Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2012

United States
Environmental Protection
Agency

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Transportation and Climate Division

Office of Transportation and Air Quality
U.S. Environmental Protection Agency

NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

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Table of Contents

Page

Table of Contents, continued

Appendices

I. Executive Summary

Introduction

This report summarizes key trends in carbon dioxide (CO_2) emissions, fuel economy, and CO_2- and fuel economy-related technology for gasoline- and diesel-fueled personal vehicles sold in the United States, from model years (MY) 1975 through 2012. Personal vehicles are those vehicles that EPA classifies as cars, light-duty trucks, or medium-duty passenger vehicles. The data in this report cover the MY 1975-2012 timeframe, supersede the data in previous reports in this series, and, for many important reasons, should not be compared with data from previous years' editions of this report. Most CO_2 emissions and fuel economy values in this report have been adjusted to reflect "real world" consumer performance and therefore are not comparable to CO_2 emissions and fuel economy standards.

CO_2 emissions rates and fuel economy values reflect a very favorable multi-year trend beginning in MY 2005. Data for MY 2011 are final, whereas data for MY 2012 are preliminary and based on projected vehicle production values provided to EPA by manufacturers. The fleetwide average real world MY 2011 personal vehicle CO_2 emissions value is 398 grams per mile (g/mi) and average fuel economy is 22.4 miles per gallon (mpg), both slightly worse relative to MY 2010. Preliminary projections for MY 2012 are 374 g/mi CO_2 emissions and 23.8 miles per gallon, which, if realized, would represent one of the largest annual improvements since 1975.

One factor which almost certainly contributes to both the apparent slight worsening in MY 2011 and the large projected improvement in MY 2012 is the reduction in MY 2011 car and car parts production in Japan in the aftermath of the March 2011 earthquake, tsunami, and nuclear disasters. While it is impossible to project the precise impact, EPA estimates that the fleetwide average MY 2011 CO_2 emissions and fuel economy values would likely have been similar to or slightly better than MY 2010 levels if car production from major Japan-based manufacturers had not been constrained by the tragedies. Likewise, the improvement projected for MY 2012 would be somewhat smaller.

For more discussion of the key conclusions of this report, see the Highlights below.

What's New This Year

One change to this year's report is the addition of Section VIII on Alternative Fuel Vehicle Trends. Previous reports in this series have only included data for vehicles that are dedicated to or are expected to operate primarily on petroleum fuels, i.e., gasoline and diesel, and the primary Trends database that is the subject of this report (with the exception of Section VIII) continues to include data only from vehicles operated on petroleum fuels. Since 1975, these vehicles have represented well over 99 percent of all light-duty vehicles sold in the U.S. But, the number of vehicles dedicated to (or designed to operate frequently on) nonpetroleum fuels is increasing, and Section VIII provides relevant data from electric vehicles, plug-in hybrid electric vehicles, and compressed natural gas vehicles.

For the first time, EPA presents data on technology penetration rates by individual manufacturers, to complement the industry-wide data that have been included in the report for many years. For each manufacturer, data are presented for the maximum increases in technology deployment over 1-year, 3-year, and 5-year intervals for five "mature" technologies (fuel injection, lockup transmissions, front wheel drive, multi-valve engines, and variable valve timing) and three emerging technologies (6-speed transmissions, continuously variable transmissions, and gasoline direct injection engines). These new data are presented near the end of Section VI.

Vehicle footprint data are of increasing interest, of course, because greenhouse gas emissions and corporate average fuel economy (CAFE) standards are now footprint-based. This series of reports has included footprint data since MY 2008, the first year that manufacturers could optionally comply with footprint-based light truck CAFE standards. EPA received formal, comprehensive footprint data from all manufacturers, for the first time, in the final CAFE compliance reports for MY 2011, the first year footprint-based CAFE standards became required for all vehicles, and these data are included in this report. EPA will continue to receive, and report, formal footprint data from manufacturers in future years as well. It is important to note that, while some of the footprint data that EPA reports for MY 2008-2010 came from formal manufacturer submissions, EPA supplemented this with informal data from manufacturer websites and commercial websites, and EPA cannot be certain that the data from MY 2008-2010 is comparable, with respect to both precision and consistency, to the formal footprint data from MY 2011 and future years. For purposes of footprint trends over time, EPA has a higher level of confidence in data from MY 2011 and future years, and a lower level of confidence in data from MY 2008-2010.

The one change to manufacturer definitions in this year's report is that, due to new corporate financial relationships, Chrysler has been combined with Fiat, Ferrari, and Maserati to form the Chrysler-Fiat manufacturing group. Consistent with this new manufacturer definition and the long-standing approach of propagating current manufacturer definitions backwards in the historical database in order to protect the integrity of long-term trends, all historical Chrysler data now reflect production for the U.S. market for Fiat, Ferrari, and Maserati as well.

Two important changes initiated in the 2011 report have been retained in this year's report: 1) all car/truck classifications throughout the historical database are consistent with the regulatory definitions used by the Department of Transportation's (DOT) National Highway Traffic Safety Administration (NHTSA) for CAFE standards beginning in MY 2011, and by EPA and NHTSA for the greenhouse gas emissions and CAFE standards for MY 2012-2025, and 2) medium-duty passenger vehicles (MDPVs), which include larger sport utility vehicles (SUVs) and passenger vans, but not the largest pickup trucks, in the 8500-10,000 pound gross vehicle weight rating (GVWR) range, are included beginning with MY 2011 data.

Finally, on November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. Hyundai and Kia submitted corrected MY 2011-2013 fuel economy and CO_2 emissions data to EPA and re-labeled the majority of their model year 2012 and 2013 vehicle models on the market. The database for this report includes all Hyundai and Kia vehicles, including the corrected fuel economy values submitted by Hyundai and Kia for four MY 2011 vehicles and for a majority of Hyundai and Kia vehicles for MY 2012. The magnitude of the changes between the original fuel economy label values and the corrected fuel economy label values ranges from 1 mpg to 6 mpg. For the changes in fuel economy label values for individual vehicles, see http://www.epa.gov/fueleconomy/labelchange.htm. Since EPA's investigation into Hyundai and Kia data submissions is continuing, Hyundai and Kia-specific values are excluded from tables that list the fuel economy and CO_2 emissions performance for individual manufacturers, but are generally provided in footnotes associated with the tables.

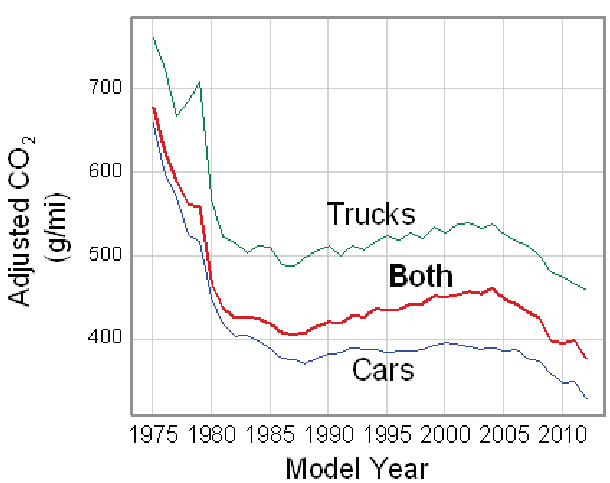
Highlight #1: CO_2 emission rates and fuel economy values reflect a very favorable multi-year trend, beginning with MY 2005.

MY 2011 adjusted composite CO_2 emissions are 398 g/mi, a 4 g/mi increase relative to the record low set in MY 2010. MY 2011 adjusted composite fuel economy is 22.4 mpg, 0.2 mpg lower than the historic high set in MY 2010. Preliminary MY 2012 values are 374 g/mi CO_2 emissions and 23.8 mpg fuel economy, which, if achieved, will be amongst the largest single year improvements since 1975.

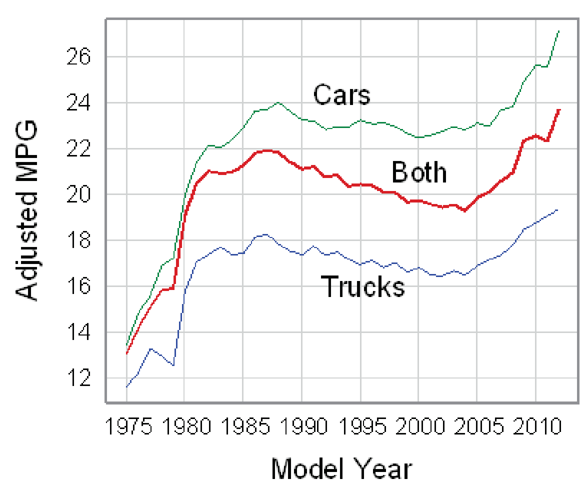
One factor which contributes to both the apparent slight worsening in MY 2011 and the large projected improvement in MY 2012 is the reduction in MY 2011 car and car parts production in Japan in the aftermath of the March 2011 earthquake, tsunami, and nuclear disasters. For example, MY 2011 car production by Toyota and Honda was over 500,000 units lower relative to MY 2010, while the rest of the industry, collectively, increased car production in MY 2011. While it is impossible to project the precise industry-wide impact, since some of this lower car production was likely captured by other manufacturers, EPA estimates that the fleetwide average MY 2011 CO_2 emissions and fuel economy values would likely have been similar to or slightly higher than MY 2010 levels if car production from major Japan-based manufacturers had not been constrained by the tragedies. Likewise, the improvement projected for MY 2012 would be somewhat less had the final MY 2011 fuel economy value been greater.

While year-to-year changes often receive the most public attention, annual values can be volatile for many reasons and the greatest value of the historical trends database is the identification and documentation of longer-term trends. For example, there have been three major factors that have contributed to year-to-year volatility since 2009: the economic recession in MY 2009; rising and volatile gasoline and diesel fuel prices; and the impact of the tsunami aftermath on Japan-based manufacturers. Using a 5-year timeframe (2006 and 2007 are good base years since there was little market volatility), CO_2 emission rates have decreased by 10 percent and fuel economy values have increased by 11 percent from MY 2006-2011. Based on preliminary estimates, CO_2 emission rates have decreased by 13 percent and fuel economy values have increased by 16 percent from MY 2007-2012. The improvements have been even greater since the “inflection point” year in 2004.

Adjusted CO_2 Emissions



Adjusted Fuel Economy

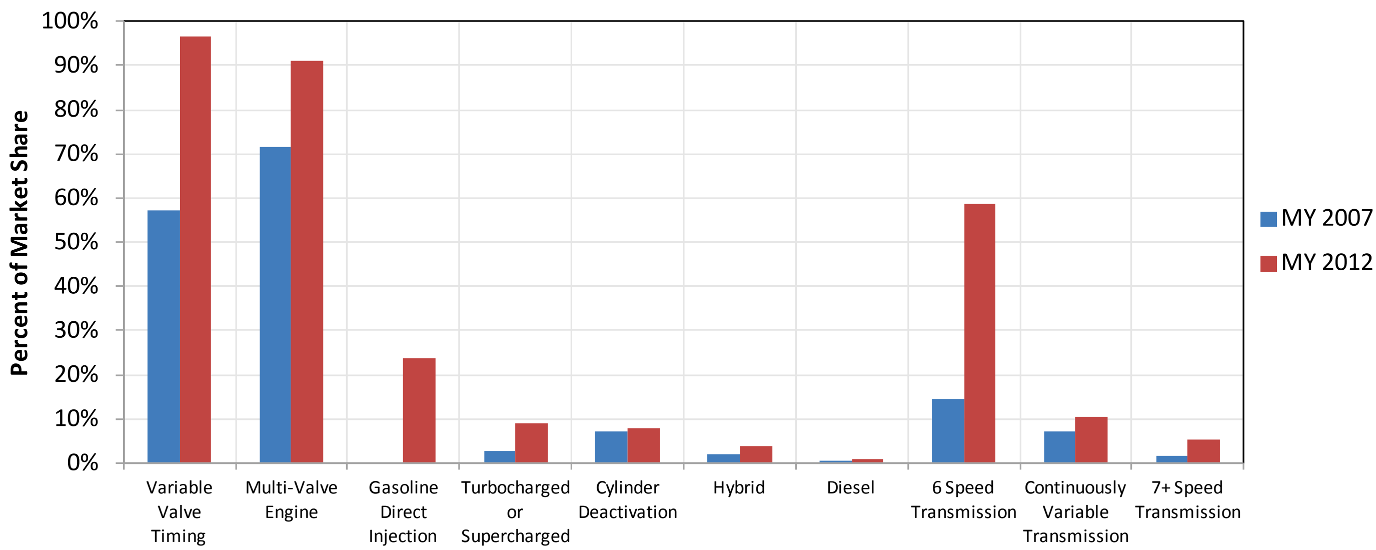


Highlight #2: Many new technologies are rapidly gaining market share.

New technologies are continually being introduced into the marketplace, replacing older and less effective technologies. Technological innovation is a major driving force behind the recent improvements in CO_2 emissions and fuel economy, and the majority of the carbon and oil savings from current vehicles is due to new gasoline vehicle technologies.

Two engine technologies first introduced over 20 years ago—variable valve timing and multi-valve—are projected to be used on 90 percent or more of all MY 2012 vehicles. Through the mid-1980s, most vehicles relied on carburetors to deliver fuel to the engine. Carburetors were replaced by fuel injection systems in the late 1980s. Now, in some vehicles, conventional fuel injection systems are being replaced by more sophisticated gasoline direct injection systems, the use of which has grown from essentially zero in MY 2007 to a projected 24 percent of the market in MY 2012. The use of turbochargers/superchargers has tripled from about 3 percent in MY 2007 to a projected 9 percent in MY 2012, while the use of cylinder deactivation has remained in the 8-9 percent range. Both conventional hybrids and diesel vehicles have increased market share slightly since MY 2007.

Light Duty Vehicle Technology Penetration Share

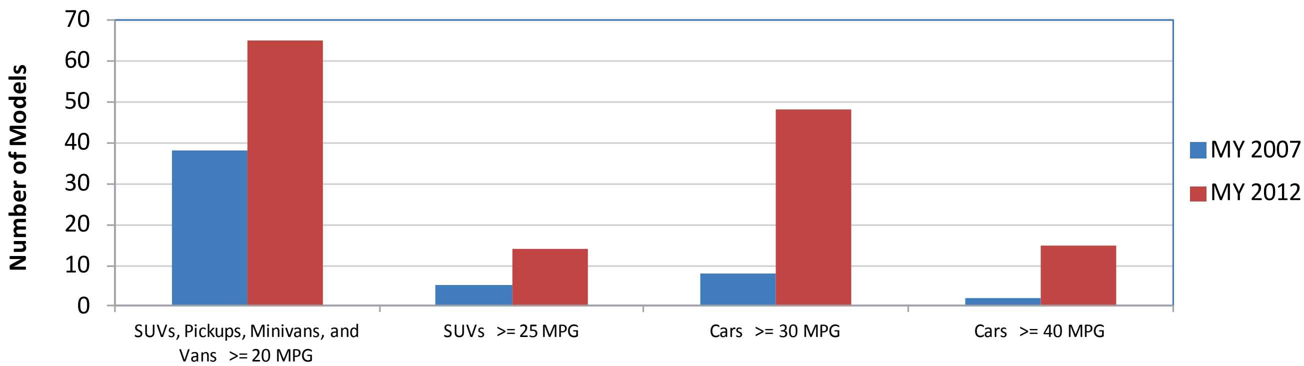


Recent changes in transmission technology adoption are particularly noteworthy. Through 2005, the 4 speed transmission was the dominant automatic transmission. Transmissions with 6 or more speeds and continuously variable transmissions cumulatively accounted for about 25% of vehicle production in MY 2007, but are projected to reach 75% market share in MY 2012.

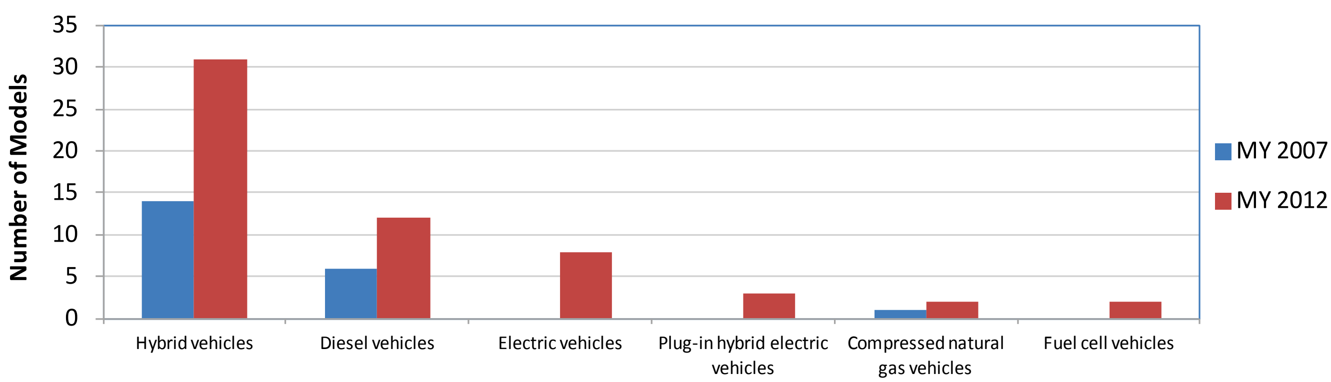
See Section VI for more detailed data on technology trends in general, as well as for new data on the maximum technology penetration rates for individual manufacturers.

Highlight #3: Consumers have an increasing number of high fuel economy/low CO_2 vehicle choices.

The U.S. personal vehicle market is diversifying, and consumers now have a much broader range of vehicle choices with respect to fuel economy/CO_2 emissions performance and powertrain technology. The number of SUV, pickup, minivan, and van models that have combined EPA label values of 20 mpg or more have increased by 71%, from 38 in 2007 to 65 in 2012. There are almost 3 times more SUVs with combined labels of 25 mpg or more and 6 times more cars with ratings of 30 mpg or more. The number of cars with 40 mpg (or higher) labels have increased from 2 in 2007 to 15 in 2012.



There are also many more advanced technology vehicle choices. In MY 2007, the only advanced technology for which there were meaningful choices was conventional hybrids (and, to a lesser degree, diesel vehicles). Today, not only are there about twice as many conventional hybrids and diesels in the market, but growing numbers of electric vehicles, plug-in hybrid electric vehicles, natural gas vehicles, and fuel cell vehicles as well. Some of these alternative fueled vehicles have limited consumer availability. For example, the two fuel cell vehicles are only available to some consumers in selected California markets.



For this analysis, the authors used engineering judgment to differentiate between those configurations that are generally marketed and perceived by consumers to be the same model (e.g., 2WD/4WD, different engine sizes and/or pickup truck wheelbases, and different trim levels were treated as one model) versus those configurations that are generally marketed and perceived by consumers to be unique vehicle choices (e.g., vehicles which are marketed separately and have distinct vehicle sizes such as the Prius, Prius v, and Prius c). This same approach was used for both MY 2007 and MY 2012. All fuel economy values in this highlight are consistent with label values and classifications. For more detail on this analysis, see the brochure and technical support memorandum at http://www.epa.gov/nvfel/showcase.htm. See fueleconomy.gov for formal EPA label values for individual vehicles.

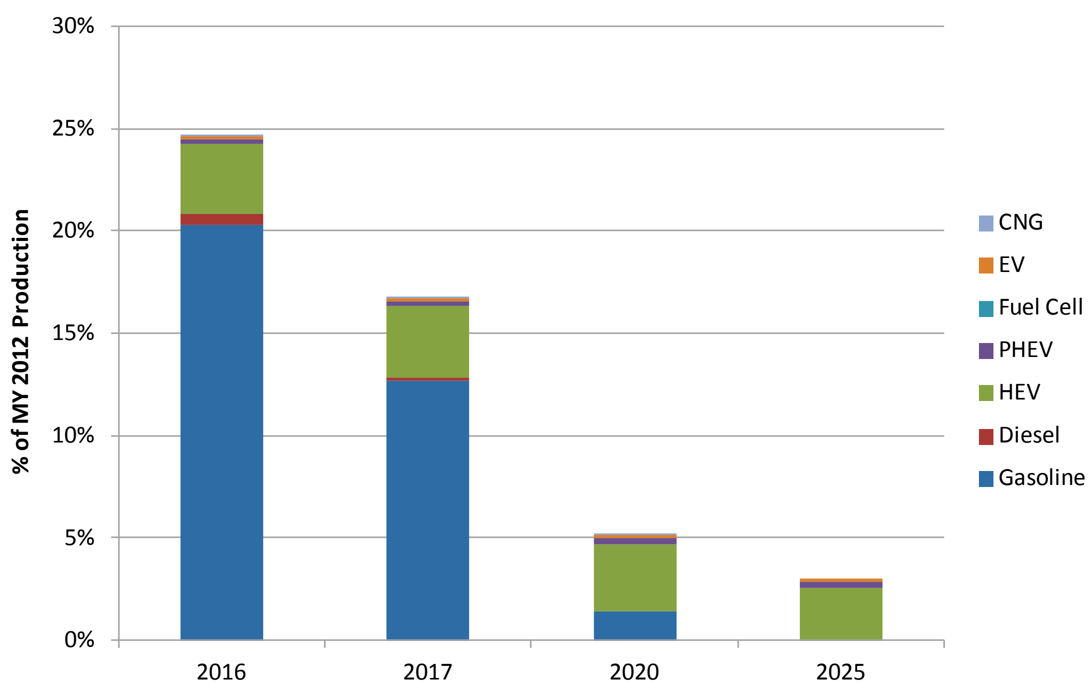
Highlight #4: Manufacturers are selling many vehicles today that can meet future CO_2 emission targets.

EPA evaluated MY 2012 vehicles against future footprint-based CO_2 emission targets to determine which vehicles could meet or exceed the targets in model years 2016-2025, based on current powertrain designs and assuming improvements in air conditioner refrigerants and efficiency. It is important to note there are no CO_2 emissions standards for individual vehicles. Rather, manufacturers are subject to corporate average standards for both their passenger car and light truck fleets. The standards are derived from the footprint-based CO_2 emissions target curves, and the production volume-weighted distribution of vehicles produced for sale in the U.S.

Nearly 25% of projected MY 2012 vehicle production already meets the MY 2016 CO_2 targets, or can meet these targets with the addition of expected air conditioning improvements. The bulk of this production share is accounted for by non-hybrid gasoline vehicles, although other technologies, including hybrids, electric vehicles, and diesel vehicles are also represented. These 25% represent approximately 80 MY 2012 vehicle models that are in showrooms today, and include a wide range of vehicle segments, including cars, SUVs, minivans, and pickup trucks.

Looking ahead, there are about 20 vehicle models (3% of projected 2012 production) that could meet the MY 2025 CO_2 targets. Vehicles meeting the MY 2025 CO_2 targets are comprised solely of hybrids, plug-in hybrids, electric vehicles, and fuel cell vehicles. Since the MY 2025 standards are over a decade away, there's considerable time for continued improvements in gasoline vehicle technology.

MY 2012 Vehicle Production Share (Projected) That Meets Future CO_2 Targets, by Technology



EPA assumed the addition of only air conditioning improvements since these are considered to be among the most straightforward and least expensive technologies available to reduce CO_2 and other greenhouse gas emissions. See the "Regulatory Context" section below for more information on CO_2 and fuel economy standards.

Highlight #5: Most manufacturers continue to increase fuel economy, resulting in lower CO_2 emission rates.

Seven of the 11 manufacturers shown below increased fuel economy from MY 2010 to MY 2011, the last two years for which we have definitive data. Preliminary MY 2012 values suggest that all manufacturers will improve in MY 2012, several by 20 g/mi CO_2 or more and 1.5 mpg or more, though these projections are uncertain and EPA will not have final data until next year's report.

In MY 2011, for the 11 manufacturers shown, Volkswagen had the lowest fleetwide adjusted composite CO_2 emissions and highest adjusted fuel economy performance, followed by Mazda and then a tie between Honda and Toyota. All of these manufacturers have average footprint values lower than the industry average. Daimler had the highest CO_2 emissions (and lowest fuel economy), followed by Chrysler-Fiat and GM. VW had the biggest improvement in adjusted CO_2 (and fuel economy) performance from MY 2010 to MY 2011, with a 14 g/mi reduction in fleetwide CO_2 emissions (and 1.0 mpg fuel economy improvement), followed by Ford (13 g/mi reduction in CO_2 emissions and 0.7 mpg improvement). The higher CO_2 and lower fuel economy values for Honda and Toyota in MY 2011 are at least partially explained by the lower car production in Japan due to the March 2011 tsunami. Section VII has greater detail on the fuel economy and CO_2 emissions for these manufacturers (e.g., for individual manufacturer car and truck fleets), as well as for these manufacturers' individual makes (i.e., brands).

MY 2010–2012 Manufacturer Fuel Economy and CO_2 Emissions[1]

Manufacturer	MY2010 MPG	MY2010 CO_2 (g/mi)	MY2011 MPG	MY2011 CO_2 (g/mi)	MY2012 MPG	MY2012 CO_2 (g/mi)
VW	25.0	363	26.0	349	26.2	346
Mazda	24.4	364	25.0	356	25.9	343
Toyota	25.4	350	24.1	369	25.6	347
Honda	24.9	357	24.1	369	26.4	337
Subaru	23.4	379	23.9	372	25.2	353
Nissan	23.1	384	23.3	381	24.6	361
BMW	22.1	404	22.7	393	23.1	386
Ford	20.4	435	21.1	422	23.2	382
GM	21.3	418	20.7	429	21.4	415
Chrysler-Fiat	19.5	455	19.4	458	20.6	431
Daimler	18.9	471	19.1	469	21.4	418
All	22.6	394	22.4	398	23.8	374

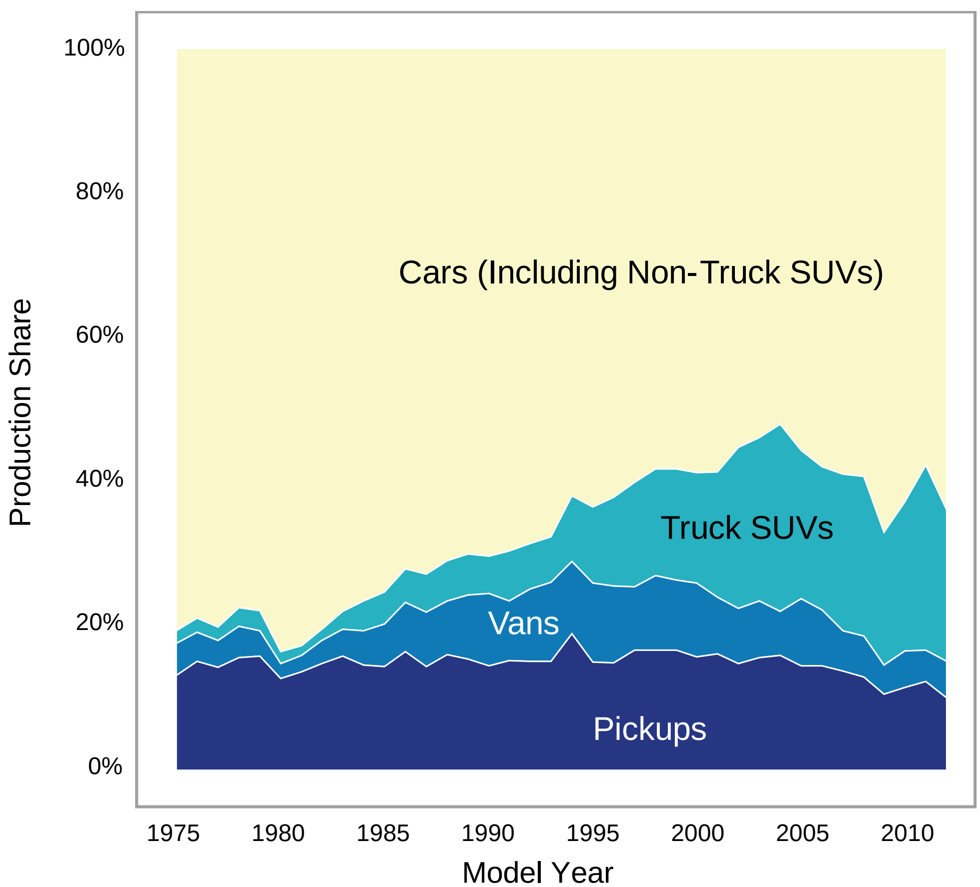
[1] Two manufacturers, Hyundai and Kia, are not included in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. This report uses the corrected fuel economy values submitted by Hyundai and Kia for four MY 2011 vehicles and for a majority of Hyundai and Kia vehicles for MY 2012. Based on these corrected data, Hyundai's 2011 values are 27.2 mpg and 327 g/mi CO_2, Hyundai's preliminary 2012 values are 28.8 mpg and 309 g/mi CO_2, Kia's 2011 values are 25.8 mpg and 345 g/mi CO_2, and Kia's preliminary 2012 values are 26.7 mpg and 333 g/mi CO_2.

Highlight #6: Truck market share continues to be volatile.

Light trucks, which include pickup trucks, minivans/vans, and most SUVs, accounted for 42 percent of all light-duty vehicle production in MY 2011. This represents a 5 percent increase over MY 2010. The MY 2012 light truck market share is projected to be 36 percent, based on pre-model year production projections by automakers, which, if realized, would return truck market share to slightly below the MY 2010 level and to the second lowest level since 1993.

Truck market share has been very volatile in recent years, decreasing by 8 percent in MY 2009, and increasing by 4 percent in MY 2010 and by 5 percent in MY 2011. Three factors that have likely contributed to the volatility in truck share include: 1) MY 2009 was a particularly unusual year due to the serious economic recession that led to much turmoil in the automotive market and almost certainly led to an artificially low truck production share in that year, which then results in an apparently larger truck production share increase since MY 2009; 2) the Car Allowance Rebate System (CARS), commonly referred to as Cash for Clunkers, managed by NHTSA, which provided incentives of up to $4500 for the trade-in of a vehicle with lower fuel economy and purchase of a new vehicle with higher fuel economy, that resulted in 677,081 new vehicle purchases in 2009, and 3) the earthquake, tsunami, and nuclear tragedies in Japan in March 2011 almost certainly decreased the supply of cars from Japan (possibly trucks as well, but likely more cars than trucks), which likely contributed to the truck share increase in MY 2011 (as well as to the projected truck share decrease in MY 2012).

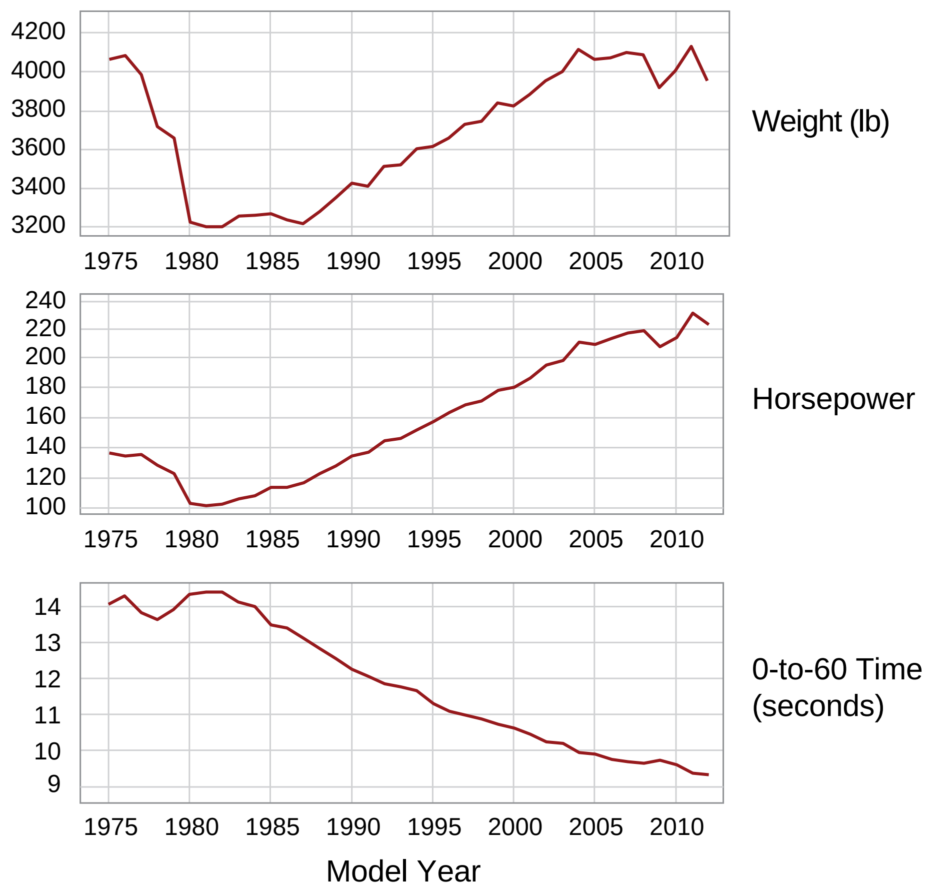
Production Share by Vehicle Type



Highlight #7: Vehicle power is at a record high, while the vehicle weight trend is generally flat.

MY 2011 vehicle weight averaged 4127 pounds, an increase of 125 pounds compared to MY 2010. The average car weight increased 81 pounds and truck weight increased 40 pounds, and the remaining difference was due to higher truck market share. In MY 2011, the average vehicle power was 230 horsepower, an increase of 16 horsepower since MY 2010. Car power increased by 10 horsepower and truck power increased by 18 horsepower, and the remaining difference was due to higher truck market share. Estimated MY 2011 0-to-60 acceleration time decreased to 9.4 seconds. Preliminary MY 2012 values suggest that average vehicle weight and power will both decrease, though these projections are uncertain and EPA will not have final data until next year's report. While the preliminary MY 2012 weight value is lower than all but one year since 2001, the preliminary MY 2012 power value would still be the second highest value ever, exceeded only by MY 2011.

Weight, Horsepower and 0-to-60 Performance



Vehicle weight and performance are two of the most important engineering parameters that help determine a vehicle's CO_2 emissions and fuel economy. In general, all other factors being equal, higher vehicle weight (which supports new options and features) and faster acceleration performance (e.g., lower 0-to-60 mile-per-hour acceleration time), both increase a vehicle's CO_2 emissions and decrease fuel economy. From MY 1987 through MY 2004, on a fleetwide basis, automotive technology innovation was generally utilized to support market-driven attributes other than CO_2 emissions and fuel economy, such as vehicle weight, performance, and utility. Beginning in MY 2005, technology has been used to increase both fuel economy (which has reduced CO_2 emissions) and performance, while keeping vehicle weight relatively constant.

Regulatory Context

CAFE standards have been in place since 1978. NHTSA has the responsibility for setting and enforcing CAFE standards. EPA is responsible for establishing fuel economy test procedures and calculation methods, and for collecting data used to determine vehicle fuel economy and manufacturer CAFE levels.

For MY 2012 through 2025, EPA and NHTSA have jointly developed a coordinated National Program which established EPA greenhouse gas emissions standards and NHTSA CAFE standards that allow manufacturers to build a single national fleet to meet requirements of both programs while ensuring that consumers have a full range of vehicle choices. The National Program has been supported by a wide range of stakeholders: most major automakers, the United Auto Workers, the State of California, and major consumer and environmental groups.

In 2010, the agencies finalized the first coordinated standards for MY 2012-2016 (75 Federal Register 25324, May 7, 2010). The standards for MY 2012 are now in effect, and are projected to require average fleetwide CO_2 emissions compliance of about 295 g/mi and average CAFE compliance of about 29.3 mpg (actual fleetwide compliance levels will depend on the mix of vehicle footprint levels). By MY 2016, the average industry-wide compliance levels for these footprint-based standards are projected to be 250 g/mi CO_2 and 34.1 mpg CAFE. The 250 g/mi CO_2 compliance level would be equivalent to 35.5 mpg if all CO_2 emissions reductions are achieved through fuel economy improvements. In 2012, the agencies finalized additional coordinated standards for MY 2017-2025 (77 Federal Register 62624, October 15, 2012). By MY 2025, the average industry-wide compliance levels are projected to be 163 g/mi CO_2 and 48.7-49.7 mpg CAFE.[2] The 163 g/mi CO_2 compliance level would be equivalent to 54.5 mpg if all CO_2 emissions reductions are achieved solely through improvements in fuel economy. For both MY 2012-2016 and MY 2017-2025, the agencies expect that a portion of the required CO_2 emissions improvements will be achieved by reductions in air conditioner refrigerant leakage, which would not contribute to higher fuel economy.

Automaker compliance with both CO_2 and CAFE standards is based on unadjusted laboratory CO_2 and fuel economy values, along with various regulatory incentives and credits. Neither unadjusted laboratory nor adjusted composite CO_2 and fuel economy values reflect various incentives (e.g., for flexible fuel vehicles for both CAFE and CO_2 standards) and credits (air conditioner and other off-cycle technologies for CO_2 standards) that are available to manufacturers for regulatory compliance. With real world (i.e., 5-cycle label) adjustments, alternative fuel vehicle credits, and test procedure adjustments, fleetwide CAFE compliance values are a minimum of 25 percent higher than EPA adjusted (5-cycle) fuel economy values. See Appendix A for a detailed comparison of EPA adjusted and laboratory fuel economy values and CAFE compliance values.

Notes on Data Contained in This Report

This report supersedes all previous reports in this series. Users of this report should rely exclusively on data in this latest report, which covers MY 1975 through 2012, and not make comparisons to data in previous reports in this series. There are several reasons for this.

One, EPA revised the methodology for estimating "real-world" (i.e., label) fuel economy values in December 2006. Every adjusted (ADJ) fuel economy value in this report for 1986 and later model years is lower than given in

[2] NHTSA CAFE standards for model years 2022-2025 are not final, and are augural. NHTSA is required by Congress to set CAFE standards for no more than five years at a time. NHTSA will conduct a new and full rulemaking in the future to establish standards for model years 2022-2025. NHTSA projects the augural standards would require a combined fleetwide fuel economy of 48.7-49.7 mpg.

reports in this series prior to the 2007 report. See Appendix A for more in-depth discussion of the current methodology and how it affects both the adjusted fuel economy values for individual models and the historical fuel economy trends database. This same methodology is used to calculate adjusted CO_2 emissions values as well. Two, beginning with the 2011 report, all car/truck classifications in this database are consistent with determinations made by NHTSA for CAFE standards beginning in MY 2011 and by EPA for CO_2 emissions standards for MY 2012 and later, which means that many small and midsize 2-wheel drive SUVs have been reclassified from trucks to cars for the entire MY 1975-2012 database.. Three, when EPA changes a manufacturer or vehicle make definition to reflect a change in the industry's current financial structure, EPA makes the same adjustment in the historical database as well. This maintains a consistent manufacturer/make definition over time, which allows the identification of long-term trends. On the other hand, it means that the database does not necessarily reflect actual past financial arrangements. For example, the 2012 database, which includes data for the entire time series MY 1975 through 2012, accounts for all Chrysler, Fiat, Ferrari, and Maserati vehicles in the 1975-2012 timeframe under the Chrysler-Fiat manufacturer designation, and does not reflect that Chrysler was combined with Daimler for several years nor that there was no historic relationship between Chrysler and Fiat/Ferrari/Maserati.

The great majority of the CO_2 emissions and fuel economy values in this report are EPA adjusted composite (ADJ COMP) city/highway real-world estimates provided to consumers and based on EPA’s 5-cycle test methodology (which represents city, highway, high speed/high acceleration, high temperature/air conditioning, and cold temperature driving) that was first implemented in MY 2008. Appendix A provides a detailed explanation of the method used to calculate these adjusted fuel economy and CO_2 values, which last changed with the 2007 version of this report. All adjusted composite city/highway fuel economy values in this report use a 43 percent city/57 percent highway weighting to be consistent with the national driving activity analysis underlying EPA’s 5-cycle fuel economy label methodology. In 2011, EPA and NHTSA revised the fuel economy and environment label to include, among other things, grams of CO_2 emissions per mile and a fuel economy and greenhouse gas emissions rating (76 Federal Register 39478, July 6, 2011).

In some tables, the report also provides unadjusted EPA laboratory (LAB) values, which are based on a 2-cycle test methodology (city and highway tests only) and are the basis for automaker compliance with CO_2 emissions and CAFE standards. All combinations of adjusted or laboratory, and CO_2 emissions or fuel economy values, may be reported as city, highway, or, most commonly, as composite (combined city/highway).

Because the underlying methodology for generating unadjusted laboratory CO_2 emissions and fuel economy values has not changed since this series began in the mid-1970s, these values provide a basis for comparing long-term CO_2 emissions and fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world driving that are reflected in the adjusted values. Laboratory composite values represent a harmonic average of 55 percent city and 45 percent highway operation, or "55/45" (the historic 55 percent city/45 percent highway weighting is still used for both CAFE compliance and the combined value on individual fuel economy labels). For 2005 and later model years, unadjusted fleetwide laboratory composite CO_2 emissions values are about 20 percent lower than adjusted composite CO_2 values, and unadjusted fleetwide laboratory composite fuel economy values are about 25 percent greater than adjusted composite fuel economy values. Neither unadjusted laboratory nor adjusted composite CO_2 and fuel economy values reflect various incentives and credits that are available to manufacturers for regulatory compliance.

Through MY 2011, the CO_2 emissions, fuel economy, vehicle characteristics, and vehicle production volume data used for this report were from the formal end-of-year submissions from automakers obtained from EPA's fuel economy database that is used for CAFE compliance purposes. For preliminary MY 2012 data, EPA has exclusively used confidential pre-model year production volume projections from automaker label submissions. Accordingly, MY 2012 projections are uncertain. Historically, as shown in Table A-1, the differences between the initial unadjusted laboratory fuel economy estimates based on vehicle production projections and later, final values have typically been within a few tenths of a mile per gallon. But, the market turmoil in MY 2009 was a major exception in this regard, as the final MY 2009 unadjusted laboratory fuel economy value from the 2010 report was 1.8 mpg higher than the preliminary unadjusted laboratory value for MY 2009 from the 2009 report based on projected production volumes. The final MY 2011 unadjusted laboratory fuel economy value is 0.5 mpg lower than the preliminary unadjusted laboratory fuel economy value for MY 2011 in the 2011 report based on projected production volumes.

The primary database in this report includes data only from vehicles certified to operate on gasoline or diesel fuel, from laboratory testing with test fuels as defined in EPA test protocols (e.g., with zero ethanol). It includes data from ethanol flexible fuel vehicles, which can operate on gasoline or an 85 percent ethanol/15 percent gasoline blend or any mixture in between, operated on gasoline only. Data from the small number of vehicles that are certified to operate only on alternative fuels or are expected to operate frequently on alternative fuels (such as plug-in hybrid electric vehicles or dual-fuel compressed natural gas vehicles) are not included in this primary database because they represented less than 0.2 percent of all production in MY 2011 and because the emissions and fuel economy data from alternative fuel vehicles raise issues with respect to the metrics that are used in this report. See the new Section VIII for relevant data from these alternative fuel vehicles.

Vehicle population data in this report represent production delivered for sale in the U.S., rather than actual sales data. Automakers submit production data in formal end-of-year CAFE compliance reports to EPA, which is the basis for this report. Accordingly, the production data in this report may differ from sales data reported by press sources, because not all vehicles produced for sale in a given model year will necessarily be sold in that model year. In addition, the data presented in this report are tabulated on a model year, not calendar year, basis.

For More Information

Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 2012 (EPA-420-R-13-001) is available on the Office of Transportation and Air Quality's (OTAQ) Web site at:

www.epa.gov/otaq/fetrends.htm

Printed copies are available from the OTAQ library at:

U.S. Environmental Protection Agency
Office of Transportation and Air Quality Library
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4311

A copy of the *Fuel Economy Guide* giving city and highway fuel economy data for individual models is available at:

www.fueleconomy.gov

or by calling the U.S. Department of Energy at (800) 423-1363.

For information about EPA's Greenhouse Gas Emissions Standards, see:

http://epa.gov/otaq/climate/regulations.htm

For information about the EPA/Department of Transportation (DOT) Fuel Economy and Environment Labels, see:

http://epa.gov/otaq/carlabel

For information about DOT's Corporate Average Fuel Economy (CAFE) program, including a program overview, related rulemaking activities, and summaries of the fuel economy performance of individual manufacturers since 1978, see:

http://www.nhtsa.dot.gov/fuel-economy

II. Introduction

This report examines light-duty vehicle technology, CO_2 emissions, and fuel economy trends since MY 1975 using the latest EPA data available. Pre-2009 reports in this series [1-35] [1] presented fuel economy and technology trends only, and did not include CO_2 emissions data. Beginning in 2009, reports [36-38] have included key CO_2 emissions summary tables as well. When comparing data in this and previous reports, please note that revisions are made for some prior model years for which more complete data have become available. In addition, important changes have been made periodically in the database, e.g., reflecting changes in manufacturer definitions, the methodology by which we calculate adjusted fuel economy values, car-truck classifications, and whether MDPVs are included in the database. Thus, it is generally not appropriate to compare values from this report with others in this series and it is not necessary to do so since each report reflects the entire database back to MY 1975.

The EPA CO_2 emissions and fuel economy database used in this report was frozen in September 2012. Through MY 2011, the CO_2 emissions, fuel economy, vehicle characteristics, and production volume data used for this report came from the formal end-of-year submissions from automakers obtained from EPA's database that is used for CAFE compliance purposes, and can be considered to be final. For MY 2012, EPA has exclusively used confidential pre-model year production projections submitted to EPA by automakers. Vehicle population data in this report represent production delivered for sale in the U.S., rather than actual sales data. Accordingly, the vehicle production data in this report may differ from sales data reported by press sources. In addition, the data presented in this report were tabulated on a model year, not calendar year, basis. In years past, manufacturers typically used a consistent approach toward model year designations, i.e., from fall of one year to the fall of the following year. More recently, however, many manufacturers have used a more flexible approach and it is not uncommon to see a new or redesigned model be introduced in the spring or summer, rather than the fall. This means that a model year for an individual vehicle can be "stretched out." Accordingly, year-to-year comparisons can be affected by these model year anomalies, though these even out over a multi-year period.

All fuel economy values in this report are production-weighted harmonic averages (necessary to maintain mathematical integrity) and all CO_2 emissions values are production-weighted arithmetic averages. In earlier reports in this series through MY 2000, the only fuel economy values used were the unadjusted laboratory-based city, highway, and composite (combined city/highway) mpg values—which are used as the basis for compliance with the fuel economy standards and the gas guzzler tax. Since the laboratory mpg values tend to over predict the mpg achieved in actual use, adjusted mpg values are used for the Government's fuel economy information programs: fueleconomy.gov, the *Fuel Economy Guide*, and the *Fuel Economy and Environment Labels* that are on new vehicles. Starting with the MY 2001 report, this series has provided fuel economy trends in adjusted mpg values in addition to the laboratory mpg values. Now, most of the tables exclusively show the adjusted CO_2 emissions and fuel economy values. A few tables include both adjusted city, highway, and composite fuel economy values and laboratory 55/45 fuel economy values. In the tables, these two mpg values are called "Adjusted MPG" and "Laboratory MPG" and are abbreviated as "ADJ" MPG and "LAB" MPG. These same metrics are used for CO_2 emissions values as well.

Where only one CO_2 or mpg value is presented in this report and it is not explicitly identified otherwise, it is the "adjusted composite" value. This value represents a combined city/highway CO_2 or fuel economy value, and is based on equations (see Appendix A) that allow a computation of adjusted city and highway values based on laboratory city and highway test values.

[1] Numbers in brackets denote references listed in the references section of this report.

It is important to note that EPA revised the methodology by which EPA estimates adjusted fuel economy values in December 2006. Every adjusted fuel economy value in this report for 1986 and later model years is lower than given in pre-2007 reports. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with corresponding values from older reports. These new downward adjustments are phased in, linearly, beginning in 1986, and for 2005 and later model years the new adjusted composite values are, on average, about six percent lower than under the methodology previously used by EPA. This same methodology is used to generate adjusted CO_2 emissions values as well. See Appendix A for more in-depth discussion of this new methodology and how it affects both the adjusted CO_2 and fuel economy values for individual models and the historical trends database.

Data are tabulated on a model year basis, but some figures use three-year moving averages which effectively smooth the trends, and these three-year moving averages are tabulated at their midpoint. For example, the midpoint for model years 2010, 2011, and 2012 is MY 2011. The fuel economy values reported by the Department of Transportation (DOT) for compliance with the Corporate Average Fuel Economy (CAFE) program are higher than the data in this report for three reasons:

1. The DOT data do not include the EPA real world fuel economy adjustments for city and highway mpg;

2. The DOT data include CAFE credits for those manufacturers that produce dedicated alternative fuel vehicles and flexible fuel vehicles (credits generated through the production of flexible fuel vehicles are currently capped at 1.2 mpg per fleet);

3. The DOT data include credits for test procedure adjustments for cars.

Accordingly, the fuel economy values in this series of reports are always lower than those reported by DOT. Table A-6, Appendix A, compares CAFE data reported by DOT with EPA adjusted and laboratory fuel economy data for MY 1975-2012. Table A-7 shows a more detailed comparison for MY 2011, by manufacturer, of values for EPA laboratory fuel economy, alternative fuel vehicle credits, test procedure adjustment credits for cars, and NHTSA CAFE performance.

Beginning in MY 2011, footprint data is obtained from the final CAFE compliance reports provided by automakers to DOT/NHTSA. It is important to note that, while some of the footprint data that EPA reports for MY 2008-2012 came from formal manufacturer submissions, EPA supplemented this with footprint data from external sources such as individual manufacturer websites, Edmunds.com, and Motortrend.com. Since the MY 2008-2010 footprint data was generated in a more piecemeal fashion, there is some uncertainty associated with this data.

In the various appendices to this report, when there is no entry under “Model Year,” that means there was no production volume for the parameter in question.

While this report contains data through MY 2012, it is important to emphasize that the data through MY 2011 is based on formal end-of-year CAFE data submitted by automakers to EPA and therefore is final data that will not change. On the other hand, the MY 2012 data is based on confidential pre-model year production volume projections provided by manufacturers to EPA in the spring/summer of 2011 and therefore are projections that may well change when final production data is presented in the next report. Given the uncertainty in the MY 2012 data, this report will often focus more on the MY 2011 data than on the MY 2012 data.

Other Variables

All vehicle weight data are based on inertia weight class (nominally curb weight plus 300 pounds). For vehicles with inertia weights up to and including the 3000-pound inertia weight class, these classes have 250-pound increments. For vehicles above the 3000-pound inertia weight class (i.e., vehicles 3500 pounds and above), 500-pound increments are used.

The light truck data in this report include vehicles classified as light-duty trucks with gross vehicle weight ratings (GVWR) up to 8500 pounds as well as, for the first time beginning with MY 2011, medium-duty passenger vehicles (MDPVs). MDPVs are large SUVs and passenger vans with GVWRs between 8500 and 10,000 pounds (MDPVs do not include the much larger number of pickup trucks in the same GVWR range). EPA does not have data for MDPVs for MY 1975-2010, so there is and will continue to be a small discontinuity in the database beginning in MY 2011. For the overall fleet in MY 2011, the inclusion of MDPVs increased projected average adjusted CO_2 emissions by 0.3 g/mi and decreased projected average adjusted fuel economy by 0.01 mpg compared to the fleet without MDPVs. For the light truck fleet in MY 2011, the inclusion of MDPVs increased projected CO_2 emissions by 0.5 g/mi and decreased average adjusted fuel economy by 0.02 mpg.

"Ton-MPG" is defined as a vehicle's mpg multiplied by its weight in tons. Ton-MPG is a measure of powertrain/drive-line efficiency. Just as an increase in vehicle mpg at constant weight can be considered an improvement in a vehicle's efficiency, an increase in a vehicle's weight at constant mpg can also be considered an improvement. "CO_2/ton" is the equivalent CO_2 metric and is reported in Section IV.

"Cubic-feet-MPG" for cars is defined in this report as the product of a car's mpg and its interior volume, including trunk space. This metric associates a relative measure of a vehicle's ability to transport both passengers and their cargo. An increase in vehicle volume at constant mpg could be considered an improvement just as an increase in mpg at constant volume can be. "CO_2/cubic feet" values are given in Section IV.

"Cubic-feet-ton-MPG" is defined in this report as a combination of the two previous metrics, i.e., a car's mpg multiplied by its weight in tons and also by its interior volume. It ascribes vehicle utility to fuel economy, weight and volume. "CO_2/ton-cubic feet"" is the equivalent CO_2 metric and is shown in Section IV.

This report also includes an estimate of 0-to-60 mph acceleration time--calculated from engine rated horsepower and vehicle weight—from the relationship:

$$t = F\,(HP/WT)^{-\mathbf{f}}$$

where the coefficients F and f are empirical parameters determined in the literature by obtaining a least-squares fit for available test data. The values for the F and f coefficients are .892 and .805, respectively, for vehicles with automatic transmissions and .967 and .775, respectively, for those with manual transmissions [39]. Other authors [40, 41, 42] have evaluated the relationships between weight, horsepower, and 0-to-60 acceleration time and have calculated and published slightly different values for the F and f coefficients. Since the equation form and coefficients were developed for vehicles with conventional powertrains with gasoline-fueled engines, we have not used the equation to estimate 0-to-60 time for vehicles with hybrid powertrains or diesel engines. Published values are used for these vehicles instead.

The 0-to-60 estimate used in this report is intended to provide a quantitative time "index" of vehicle performance capability. It is the authors' engineering judgment that, given the differences in test methods for measuring 0-to-60 time and given the fact that the weight is based on inertia weight, use of these other published values for the F and f coefficients would not result in statistically significantly different 0-to-60 averages or trends.

Car-truck classifications are based on the regulatory definitions used by NHTSA for fuel economy standards compliance beginning in MY 2011 and by EPA for CO_2 emissions standards compliance beginning in MY 2012. Accordingly, some small and mid-size 2 wheel drive SUVs that had previously been considered trucks in previous versions of this report are now classified as cars throughout the entire MY 1975-2012 database. In some tables and figures, these vehicles are identified as “non-truck SUVs.” The overall car class is typically sub-divided into cars, wagons, and non-truck SUVs. The reclassification of small and mid-size 2 wheel drive SUVs from trucks to cars affects about one million vehicles in MY 2010 and MY 2011, and reduces the absolute truck share by about 10% compared to the classification used in previous reports.

Cars and wagons are sometimes further divided into sub-classes in three different ways. One approach generally follows the fuel economy label and *Fuel Economy Guide* protocol. With this approach, sedan and wagon sub-classes are based on the interior volume (passenger plus cargo) thresholds described in the *Fuel Economy Guide* (since interior volume is undefined for the two-seater class, this report assigns an interior volume value of 50 cubic feet for all two-seater cars):

Class	Interior Volume (cubic feet)
Minicompact sedan	Up to 84
Subcompact sedan	85 to 99
Compact sedan	100 to 109
Midsize sedan	110 to 119
Large sedan	120 or more
Small wagon	Up to 129
Midsize wagon	130 to 159
Large wagon	160 or more

In the second approach for car sub-classes, large sedans and wagons are aggregated as "Large," midsize sedans and wagons are aggregated as "Midsize," and all other cars are aggregated as “Small.” The third approach uses Large Cars, Large Wagons, Midsize Cars, Midsize Wagons, Small Cars, and Small Wagons with the EPA Two-Seater, Mini compact, Subcompact, and Compact sedan classes combined into the "Small Car" class. In some tables and figures in this report wagons have been merged with cars. This is because the wagon production fraction, in some instances, is so small that the information is more conveniently represented by combining the two vehicle types. When they have been combined, the differences between them are insignificant.

The truck sub-classification scheme divides pickups, vans, and Truck SUVs into "Small," "Midsize," and "Large." These truck size classifications are based primarily on published wheelbase data according to the following criteria:

	Pickup	Van	Truck SUV
Small	Less than 105"	Less than 109"	Less than 100"
Midsize	105" to 115"	109" to 124"	100" to 110"
Large	More than 115"	More than 124"	More than 110"

This classification scheme is similar to that used in many trade and consumer publications. For those vehicle nameplates with a variety of wheelbases, the size classification was determined by considering only the smallest wheelbase produced.

Published data from external sources is also used for three other engine or vehicle characteristics for which data has not always been submitted to EPA by the automotive manufacturers, or to supplement data that is submitted to EPA: (1) engines with variable valve timing (VVT) that use either cams or electric solenoids to provide variable intake and/or exhaust valve timing and in some cases valve lift; (2) engines with cylinder deactivation, which involves allowing the valves of selected cylinders of the engine to remain closed under certain driving conditions; and (3) vehicle footprint, which is the product of wheelbase times average track width and upon which future CAFE (MY 2011 and later) and CO_2 emissions standards are based. Beginning with final data for MY 2011, manufacturers will be submitting data on these engine or vehicle characteristics to EPA.

III. Fuel Economy Trends

Figure 1 and Table 1 depict time trends in car, light truck, and car-plus-light truck fuel economy, as well as truck production share, with the individual data points representing the data for each year, and trend lines representing three-year moving averages. Since 1975, the fuel economy of the combined car and light truck fleet has moved through several phases:

1. A rapid increase from 1975 through 1981;
2. A slow increase until reaching its peak in 1987;
3. A gradual decline until 2004; and
4. An increase beginning in 2005, with the largest annual increases in 2009 and 2012.

Figure 1

Adjusted Fuel Economy and Percent Truck by Model Year
(with Three-Year Moving Average)

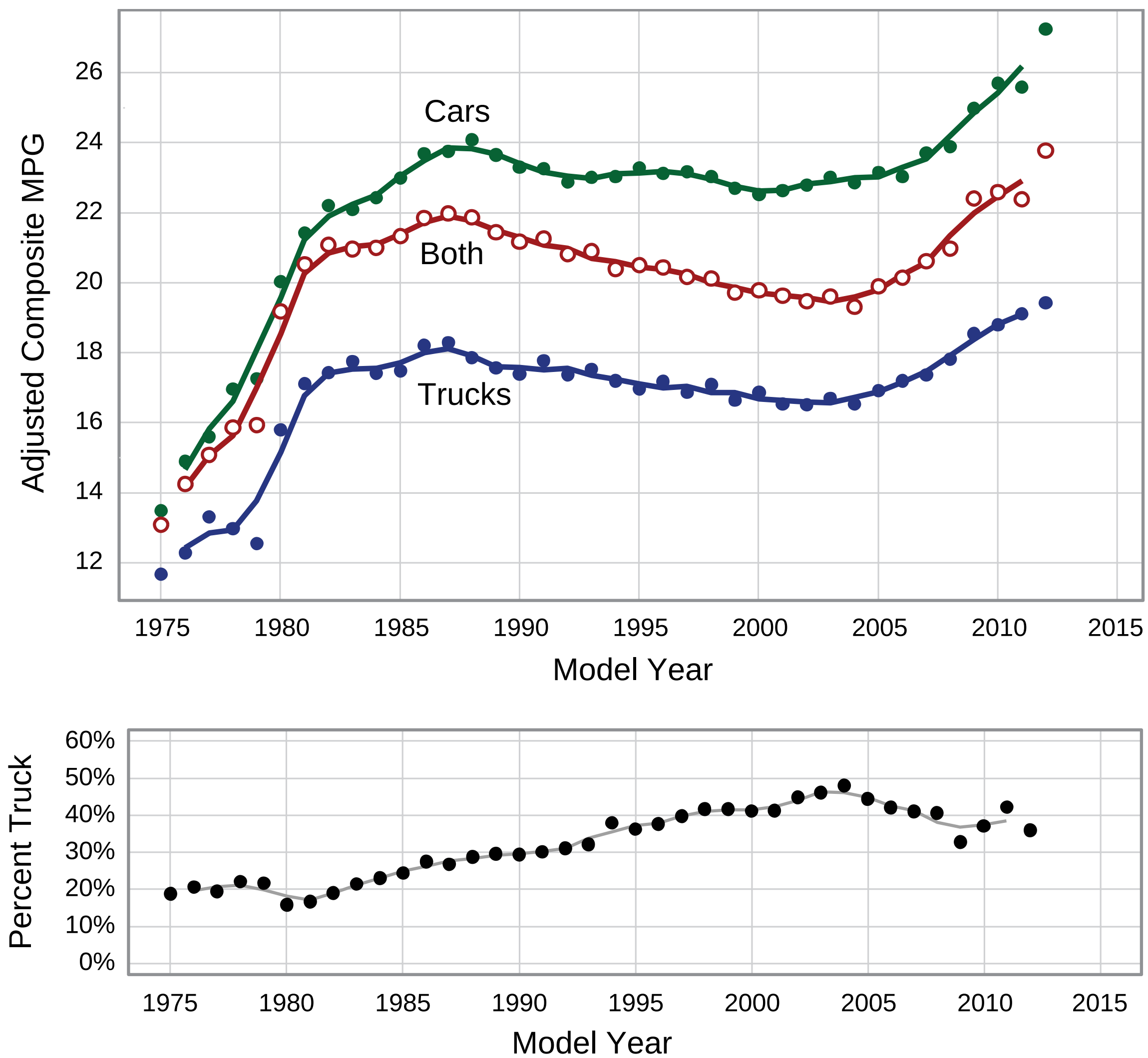


Table 1

Fuel Economy of MY 1975 to 2012 Light Duty Vehicles

Cars

Model Year	Production (000)	Production Percent	Lab City MPG	Lab Hwy MPG	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Cu Ft-MPG	Cu Ft-Ton-MPG
1975	8247	80.7%	13.7	19.5	15.8	12.3	15.2	13.5	27.5	-	-
1976	9734	78.9%	15.2	21.3	17.5	13.7	16.6	14.9	30.2	-	-
1977	11318	80.1%	16.0	22.2	18.3	14.4	17.4	15.6	31.0	1779	3422
1978	11191	77.5%	17.2	24.5	19.9	15.5	19.1	16.9	30.6	1907	3343
1979	10810	77.9%	17.7	24.6	20.2	15.9	19.2	17.2	30.2	1922	3300
1980	9444	83.5%	20.3	29.0	23.5	18.3	22.6	20.0	31.2	2136	3273
1981	8734	82.8%	21.7	31.1	25.1	19.5	24.2	21.4	33.1	2338	3547
1982	7832	80.5%	22.3	32.7	26.0	20.1	25.5	22.2	34.2	2418	3644
1983	8035	78.0%	22.1	32.6	25.9	19.9	25.5	22.1	34.7	2476	3776
1984	10730	76.5%	22.4	33.3	26.3	20.2	25.9	22.4	35.1	2481	3778
1985	10879	75.2%	22.9	34.3	26.9	20.6	26.7	23.0	35.8	2553	3888
1986	11074	72.1%	23.7	35.5	27.9	21.2	27.6	23.7	36.2	2597	3901
1987	10826	72.8%	23.8	35.8	28.0	21.2	27.7	23.8	36.2	2582	3874
1988	10845	70.9%	24.2	36.5	28.5	21.4	28.1	24.1	36.9	2628	3963
1989	10126	70.1%	23.7	36.2	28.1	20.8	27.8	23.6	36.8	2588	3977
1990	8875	70.4%	23.4	35.9	27.7	20.4	27.4	23.3	37.1	2526	3984
1991	8748	69.6%	23.4	36.0	27.8	20.4	27.4	23.3	37.0	2532	3974
1992	8350	68.6%	22.9	35.9	27.4	19.8	27.2	22.9	37.3	2524	4071
1993	8929	67.6%	23.2	36.1	27.6	19.9	27.3	23.0	37.4	2555	4096
1994	8747	61.9%	23.2	36.4	27.7	19.8	27.4	23.0	37.7	2541	4107
1995	9616	63.5%	23.4	37.3	28.1	19.8	27.9	23.3	38.2	2576	4171
1996	8177	62.2%	23.3	37.1	28.0	19.7	27.6	23.1	38.2	2562	4187
1997	8695	60.1%	23.5	37.3	28.2	19.7	27.6	23.2	38.1	2551	4160
1998	8425	58.3%	23.4	37.2	28.1	19.5	27.5	23.0	38.5	2547	4211
1999	8865	58.3%	23.2	36.8	27.8	19.2	27.0	22.7	38.6	2518	4243
2000	9742	58.8%	23.1	36.5	27.7	19.0	26.7	22.5	38.4	2511	4243
2001	9148	58.6%	23.4	36.7	27.9	19.1	26.7	22.6	38.8	2532	4286
2002	8904	55.3%	23.7	37.0	28.3	19.2	26.8	22.8	39.1	2560	4341
2003	8496	53.9%	24.0	37.6	28.7	19.3	27.1	23.0	39.8	2585	4410
2004	8176	52.0%	23.8	37.6	28.5	19.1	27.0	22.9	40.2	2597	4499
2005	8839	55.6%	24.4	38.0	29.1	19.4	27.2	23.1	40.8	2678	4645
2006	8744	57.9%	24.2	37.9	28.9	19.2	27.1	23.0	41.4	2663	4706
2007	9001	58.9%	25.0	38.9	29.8	19.8	27.8	23.7	42.6	2736	4805
2008	8243	59.3%	25.2	39.2	30.1	20.0	28.0	23.9	43.1	2755	4860
2009	6244	67.0%	26.6	40.9	31.6	21.0	29.2	25.0	44.2	2863	4961
2010	6969	62.7%	27.5	42.0	32.6	21.7	29.9	25.7	46.5	3015	5285
2011	6934	57.8%	27.0	42.2	32.3	21.3	30.1	25.6	47.0	3022	5421
2012	-	63.9%	29.2	44.9	34.6	22.9	31.8	27.3	48.3	3161	5450

Table 1 (Continued)

Fuel Economy of MY 1975 to 2012 Light Duty Vehicles

Trucks

Model Year	Production (000)	Production Percent	Lab City MPG	Lab Hwy MPG	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG
1975	1977	19.3%	12.1	16.2	13.7	10.9	12.7	11.6	24.2
1976	2600	21.1%	12.8	16.9	14.4	11.6	13.2	12.2	26.0
1977	2805	19.9%	14.1	18.1	15.6	12.6	14.2	13.3	28.0
1978	3257	22.5%	13.8	17.5	15.3	12.4	13.7	12.9	27.5
1979	3072	22.1%	13.4	16.8	14.7	12.1	13.1	12.5	27.3
1980	1863	16.5%	16.5	21.9	18.6	14.8	17.1	15.8	30.9
1981	1821	17.2%	17.8	23.9	20.1	16.0	18.6	17.1	33.0
1982	1901	19.5%	18.1	24.4	20.5	16.3	19.0	17.4	33.8
1983	2267	22.0%	18.3	25.1	20.8	16.5	19.6	17.7	34.0
1984	3289	23.5%	17.9	24.7	20.4	16.1	19.3	17.4	33.5
1985	3581	24.8%	18.0	24.8	20.5	16.2	19.3	17.5	33.7
1986	4291	27.9%	18.8	25.9	21.4	16.8	20.1	18.2	34.3
1987	4039	27.2%	18.8	26.4	21.6	16.8	20.4	18.3	34.2
1988	4450	29.1%	18.3	26.1	21.1	16.2	20.1	17.8	34.5
1989	4327	29.9%	18.1	25.7	20.9	15.9	19.8	17.6	34.7
1990	3740	29.6%	17.8	25.8	20.7	15.6	19.8	17.4	35.1
1991	3825	30.4%	18.2	26.5	21.2	15.9	20.2	17.8	35.4
1992	3822	31.4%	17.8	26.1	20.8	15.4	19.9	17.3	35.5
1993	4281	32.4%	18.0	26.6	21.0	15.5	20.1	17.5	36.0
1994	5378	38.1%	17.7	26.0	20.7	15.2	19.6	17.2	35.8
1995	5529	36.5%	17.5	25.9	20.5	14.9	19.4	17.0	35.8
1996	4967	37.8%	17.7	26.4	20.8	15.0	19.8	17.2	36.7
1997	5762	39.9%	17.4	26.0	20.5	14.7	19.4	16.8	37.1
1998	6030	41.7%	17.6	26.5	20.8	14.8	19.7	17.1	37.0
1999	6350	41.7%	17.3	25.8	20.3	14.5	19.1	16.6	37.1
2000	6829	41.2%	17.6	26.1	20.7	14.7	19.3	16.8	37.3
2001	6458	41.4%	17.4	25.6	20.3	14.4	18.8	16.5	37.6
2002	7211	44.7%	17.4	25.7	20.3	14.3	18.8	16.5	38.1
2003	7277	46.1%	17.6	26.2	20.7	14.4	19.1	16.7	38.9
2004	7533	48.0%	17.4	26.1	20.5	14.2	18.9	16.5	39.5
2005	7053	44.4%	17.8	26.9	21.0	14.4	19.5	16.9	40.3
2006	6360	42.1%	18.2	27.3	21.4	14.6	19.7	17.2	41.0
2007	6275	41.1%	18.3	27.7	21.6	14.8	20.0	17.4	42.3
2008	5656	40.7%	18.8	28.5	22.2	15.1	20.5	17.8	43.2
2009	3071	33.0%	19.6	29.7	23.1	15.7	21.4	18.5	44.1
2010	4141	37.3%	19.9	30.1	23.4	15.9	21.7	18.8	45.0
2011	5069	42.2%	20.2	30.7	23.9	16.2	22.1	19.1	46.2
2012	-	36.1%	20.5	31.3	24.3	16.4	22.5	19.4	46.5

Table 1 (Continued)

Fuel Economy of MY 1975 to 2012 Light Duty Vehicles

Cars and Trucks

Model Year	Production (000)	Lab City MPG	Lab Hwy MPG	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG
1975	10224	13.4	18.7	15.3	12.0	14.6	13.1	26.9
1976	12334	14.6	20.2	16.7	13.2	15.7	14.2	29.3
1977	14123	15.6	21.3	17.7	14.0	16.6	15.1	30.4
1978	14448	16.3	22.5	18.6	14.7	17.5	15.8	29.9
1979	13882	16.5	22.3	18.7	14.9	17.4	15.9	29.5
1980	11306	19.6	27.5	22.5	17.6	21.5	19.2	31.2
1981	10554	20.9	29.5	24.1	18.8	23.0	20.5	33.1
1982	9732	21.3	30.7	24.7	19.2	23.9	21.1	34.1
1983	10302	21.2	30.6	24.6	19.0	23.9	21.0	34.5
1984	14020	21.2	30.8	24.6	19.1	24.0	21.0	34.7
1985	14460	21.5	31.3	25.0	19.3	24.4	21.3	35.3
1986	15365	22.1	32.2	25.7	19.8	25.0	21.8	35.7
1987	14865	22.2	32.6	25.9	19.8	25.3	22.0	35.7
1988	15295	22.1	32.7	25.9	19.6	25.2	21.9	36.2
1989	14453	21.7	32.3	25.4	19.1	24.8	21.4	36.2
1990	12615	21.4	32.2	25.2	18.7	24.6	21.2	36.5
1991	12573	21.6	32.5	25.4	18.8	24.7	21.3	36.5
1992	12172	21.0	32.1	24.9	18.2	24.4	20.8	36.8
1993	13211	21.2	32.4	25.1	18.2	24.4	20.9	37.0
1994	14125	20.8	31.6	24.6	17.8	23.8	20.4	37.0
1995	15145	20.8	32.1	24.7	17.7	24.1	20.5	37.3
1996	13144	20.8	32.2	24.8	17.6	24.0	20.4	37.6
1997	14458	20.6	31.8	24.5	17.4	23.6	20.2	37.7
1998	14456	20.6	31.9	24.5	17.2	23.6	20.1	37.9
1999	15215	20.3	31.2	24.1	16.9	23.0	19.7	38.0
2000	16571	20.5	31.4	24.3	16.9	23.0	19.8	38.0
2001	15605	20.5	31.1	24.2	16.8	22.8	19.6	38.3
2002	16115	20.4	30.9	24.1	16.6	22.5	19.5	38.7
2003	15773	20.6	31.3	24.3	16.7	22.7	19.6	39.4
2004	15709	20.2	31.0	24.0	16.3	22.4	19.3	39.9
2005	15892	21.0	32.1	24.8	16.8	23.1	19.9	40.6
2006	15104	21.2	32.6	25.2	17.0	23.4	20.1	41.2
2007	15276	21.8	33.4	25.8	17.4	24.0	20.6	42.5
2008	13898	22.1	34.0	26.3	17.7	24.4	21.0	43.2
2009	9315	23.8	36.4	28.2	18.9	26.0	22.4	44.2
2010	11110	24.1	36.6	28.4	19.1	26.2	22.6	45.9
2011	12003	23.6	36.4	28.1	18.8	26.1	22.4	46.6
2012	-	25.3	38.8	30.0	20.0	27.7	23.8	47.6

As shown in Table 1, the final fleetwide MY 2011 adjusted composite fuel economy is 22.4 mpg. This MY 2011 value is 0.2 mpg lower than the all-time high set in MY 2010. The projected MY 2012 fleetwide fuel economy value is 23.8 mpg, but there is uncertainty about MY 2012 projections given that they are based on automaker submissions to EPA in the spring and summer of 2011. The reduction in fuel economy for MY 2011 is the first time fuel economy has dropped in seven years, though projections for MY 2012 show a large improvement in fuel economy. Based on laboratory 55/45 fuel economy values which reflect vehicle design considerations only, the MY 2011 unadjusted fuel economy value is 28.1mpg.

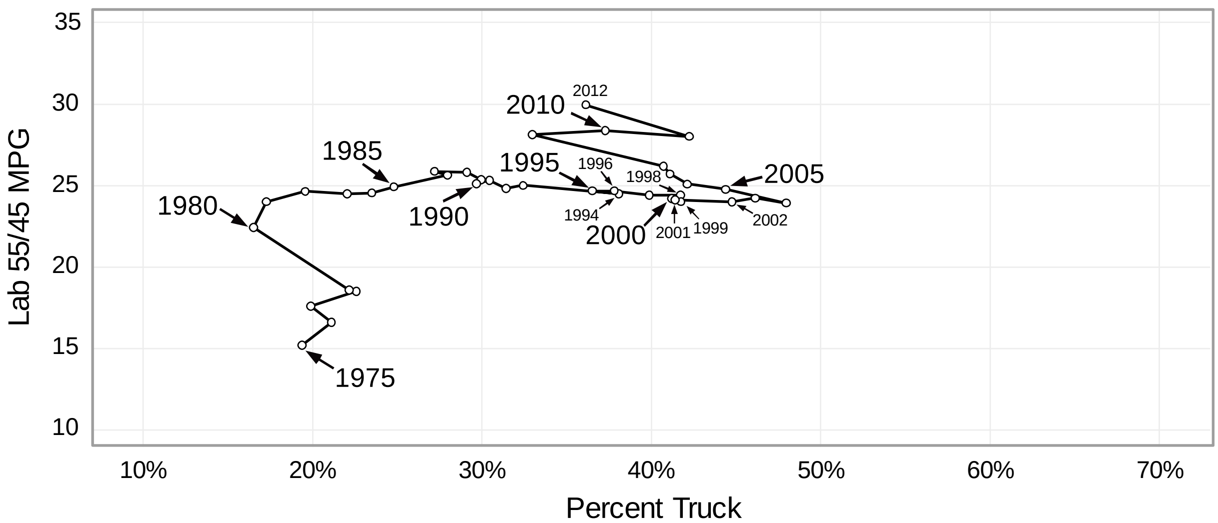
Table 1 also shows that light truck production share peaked at 48% in 2004, decreased significantly to 33% in MY 2009, and is 42% in MY 2011. Truck market share is now just 6 percent lower than the peak in MY 2004, and recent increases in truck market share have now offset most of the 15 percent decrease in truck market share from 2004-2009. Two factors that have likely contributed to the volatility in truck share are: 1) MY 2009 was a particularly unusual year due to the serious economic recession that led to much turmoil in the automotive market and almost certainly led to an artificially low truck production share in that year, which then results in an apparently larger truck production share increase since MY 2009; and 2) the earthquake, tsunami, and nuclear tragedies in Japan in March 2011 almost certainly decreased the supply of cars from Japan (possibly trucks as well, but likely more cars than trucks), and this also likely contributed to the truck share increase in MY 2011 (as well as to the projected truck share decrease in MY 2012). The MY 2012 projection is for truck production share to decrease by 6%.

Figure 1 shows the long-term fuel economy trends and truck market share trends with a three-year moving average, which tends to even out year-to-year fluctuations, such as in MY 2009, and shows that, on a 3-year moving average basis, truck share has been fairly stable with considerable year-to-year volatility. Figure 2 shows laboratory 55/45 fuel economy values for the combined car and truck fleet plotted against truck production share.

The MY 2011 adjusted fuel economy for cars is 25.6 mpg, which was a 0.1 mpg drop from the all-time high set in MY 2010. For MY 2011, the adjusted fuel economy for light trucks is 19.1 mpg, a record high. Fuel economy standards were unchanged for MY 1996 through MY 2004. In 2003, DOT raised the truck CAFE standards for MY 2005–2007, and DOT subsequently raised the truck CAFE standards for MY 2008–2025 through four separate final rules. The recent fuel economy improvement for trucks is likely due, in part, to these higher standards. The CAFE standard for cars has also been raised for MY 2011–2025 as a result of three separate final rules. The final rule for MY 2012-2016 for both cars and trucks is at 75 Federal Register 25324, May 7, 2010, and the final rule for MY 2017-2025 for both cars and trucks is at 77 Federal Register 62624, October 15, 2012.

Figure 2

Truck Production Share vs. Fleet MPG by Model Year

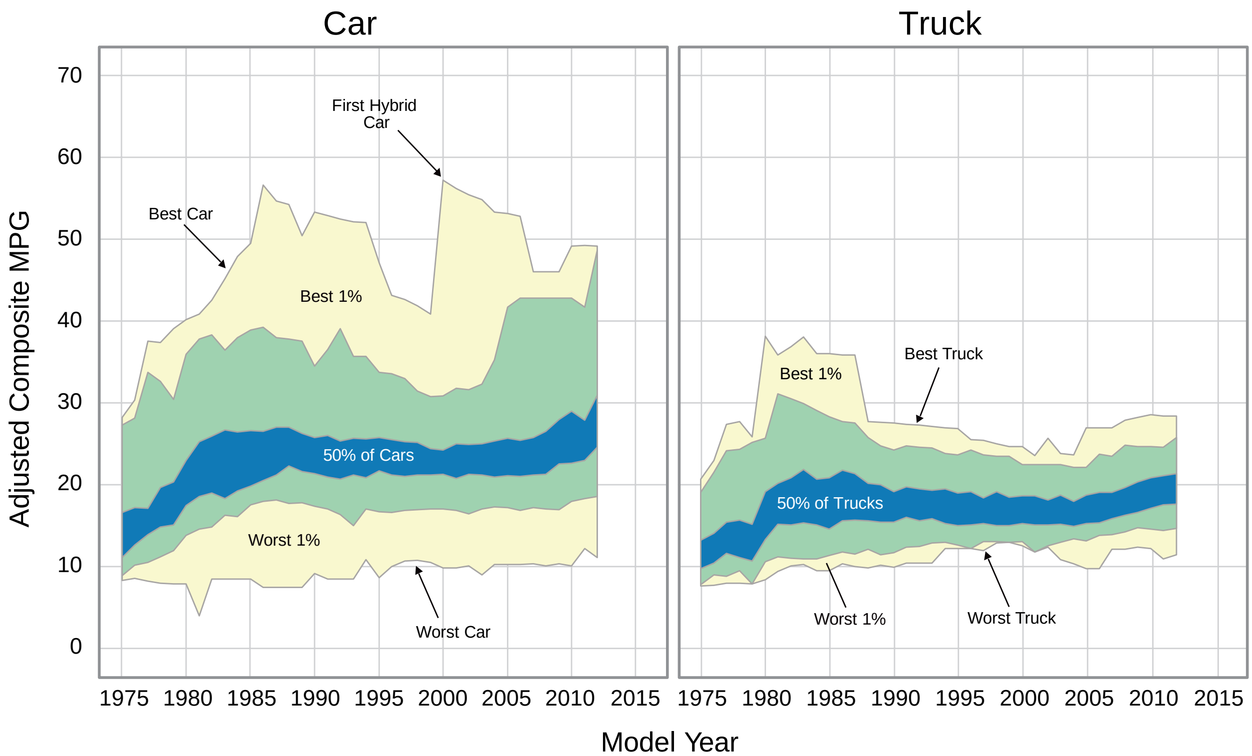


The distribution of fuel economy by model year is of interest. In Figure 3, highlights of the distribution of gasoline/diesel car and truck mpg are shown. Since 1975, half of the cars have consistently been within a few mpg of each other. The fuel economy difference between the least efficient and most efficient car increased from about 20 mpg in 1975 to nearly 50 mpg in 1986. The increased production share of hybrid cars accounts for the increase in the fuel economy of the best one percent of cars with the cut point for this stratum now nearly 50 mpg. The ratio of the highest to lowest has increased from about three to one in 1975 to nearly five to one today, because the fuel economy of the least fuel efficient cars has remained roughly constant in comparison to the most fuel efficient cars whose fuel economy has nearly doubled since 1975.

The overall fuel economy distribution trend for trucks is narrower than that for cars, with a peak in the efficiency of the most efficient truck in the early 1980s when small pickup trucks equipped with diesel engines were sold. As a result, the fuel economy range between the most efficient and least efficient truck peaked at about 25 mpg in 1982. The fuel economy range for trucks then narrowed, and is now about 20 mpg. Like cars, half of the trucks built each year have always been within a few mpg of each year's average fuel economy value. Appendix C contains additional fuel economy distribution data.

Figure 3

Production Weighted Fuel Economy Distribution



As shown in Table 2, MY 2011 vehicle weight averaged 4127 pounds and is an all-time high. This reflects an increase of 125 pounds (3%) compared to MY 2010, which is also the greatest single year-to-year increase since 1975. The average MY 2011 car increased 81 pounds, the average truck increased 40 pounds, and the remaining impact was due to higher truck production share. In MY 2011, the average vehicle power was 230 horsepower, a record high. Average vehicle power increased by 16 horsepower (7%); the largest annual increase in history. Both weight and power are projected to decrease in MY 2012, with weight expected to drop 177 pounds and power projected to drop by 8 horsepower.

Table 2 also includes vehicle footprint in square feet since MY 2008. Footprint is one metric for vehicle size, and is the product of wheelbase and average track width. Essentially, footprint is the area defined by the four points where the tires touch the ground. Footprint is a very important parameter as MY 2011 passenger car and light truck CAFE standards, and MY 2012–2025 CAFE and CO_2 emissions standards, are all footprint-based, i.e., vehicles with different footprint values have different fuel economy and CO_2 compliance targets. The MY 2008-2010 footprint data in Table 2 is tabulated from formal manufacturer submissions as well as external sources such as individual manufacturer websites, Edmunds.com, and Motortrend.com, while the MY 2011 data came from final CAFE reports provided to DOT/NHTSA from the manufacturers. Accordingly, due to the more piecemeal way that the 2008-2010 footprint data were obtained, there is some uncertainty in comparing values through MY 2010 with values beginning in MY 2011 and the most meaningful footprint trends will be those based on comparisons in MY 2011 and later.

For MY 2011, industry-wide footprint values were 46.0 square feet for cars, 54.4 square feet for trucks, and 49.5 square feet for cars and trucks combined. Car and truck footprints both increased in MY 2011 compared to MY 2010 and the overall industry footprint increased by 0.9 square feet. The average footprint in MY 2012 is projected to decrease by 0.7 square feet for cars and increase by 0.1 square feet for trucks. The average footprint of the industry as a whole is projected to decrease 0.9 square feet, due in part to the projected lower truck share.

The long-term trend since 1981 for both weight and power has been steady increases. MY 2011 weight is nearly 1000 pounds greater, and MY 2011 power has more than doubled, as compared to MY 1981. As shown in Figure 4, since 1975, Ton-MPG for both cars and trucks increased substantially. Typically, Ton-MPG for both vehicle types has increased at a rate of about one or two percent a year.

Table 2

Vehicle Size and Design Characteristics of MY 1975 to 2012 Light Duty Vehicles

Cars

Model Year	Production Percent	Adj Comp MPG	Vol (cu ft)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time (sec)	Small	Midsize	Large
1975	80.7%	13.5	-	4057	-	136	0.0331	14.2	55.4%	23.3%	21.2%
1976	78.9%	14.9	-	4059	-	134	0.0324	14.4	55.4%	25.2%	19.4%
1977	80.1%	15.6	110	3944	-	133	0.0335	14.0	52.0%	24.5%	23.5%
1978	77.5%	16.9	109	3588	-	124	0.0342	13.7	44.7%	34.4%	20.9%
1979	77.9%	17.2	109	3485	-	119	0.0338	13.8	43.7%	34.2%	22.1%
1980	83.5%	20.0	104	3101	-	100	0.0322	14.3	54.4%	34.4%	11.3%
1981	82.8%	21.4	106	3076	-	99	0.0320	14.4	51.5%	36.4%	12.2%
1982	80.5%	22.2	106	3053	-	99	0.0320	14.4	56.6%	30.9%	12.5%
1983	78.0%	22.1	109	3112	-	104	0.0330	14.0	53.0%	31.9%	15.0%
1984	76.5%	22.4	108	3101	-	106	0.0338	13.8	57.1%	29.7%	13.2%
1985	75.2%	23.0	108	3096	-	111	0.0354	13.3	55.3%	29.5%	15.2%
1986	72.1%	23.7	107	3043	-	111	0.0360	13.2	59.2%	28.3%	12.5%
1987	72.8%	23.8	107	3035	-	113	0.0365	13.0	63.2%	24.8%	12.1%
1988	70.9%	24.1	107	3051	-	116	0.0375	12.8	64.5%	22.8%	12.7%
1989	70.1%	23.6	108	3104	-	121	0.0387	12.4	58.0%	28.7%	13.4%
1990	70.4%	23.3	107	3178	-	129	0.0401	12.1	58.4%	28.9%	12.7%
1991	69.6%	23.3	107	3168	-	133	0.0413	11.9	60.4%	27.6%	12.0%
1992	68.6%	22.9	109	3254	-	141	0.0427	11.5	55.5%	29.4%	15.2%
1993	67.6%	23.0	109	3241	-	140	0.0427	11.5	54.7%	32.7%	12.6%
1994	61.9%	23.0	109	3268	-	144	0.0432	11.4	57.0%	28.2%	14.8%
1995	63.5%	23.3	109	3274	-	153	0.0460	10.9	56.3%	30.0%	13.7%
1996	62.2%	23.1	109	3297	-	155	0.0463	10.8	52.9%	33.9%	13.2%
1997	60.1%	23.2	109	3285	-	156	0.0468	10.7	54.5%	31.7%	13.7%
1998	58.3%	23.0	109	3334	-	160	0.0473	10.6	47.7%	41.4%	10.8%
1999	58.3%	22.7	110	3390	-	164	0.0479	10.5	45.8%	42.2%	12.0%
2000	58.8%	22.5	110	3401	-	168	0.0489	10.4	45.8%	37.1%	17.1%
2001	58.6%	22.6	110	3411	-	169	0.0491	10.3	48.2%	35.8%	16.0%
2002	55.3%	22.8	111	3415	-	173	0.0502	10.2	46.6%	39.0%	14.5%
2003	53.9%	23.0	111	3437	-	176	0.0508	10.0	47.8%	36.9%	15.3%
2004	52.0%	22.9	112	3492	-	184	0.0520	9.8	44.3%	38.9%	16.8%
2005	55.6%	23.1	113	3498	-	183	0.0516	9.9	40.6%	40.7%	18.6%
2006	57.9%	23.0	113	3563	-	194	0.0536	9.6	42.2%	35.8%	22.1%
2007	58.9%	23.7	113	3551	-	191	0.0530	9.6	40.0%	42.7%	17.3%
2008	59.3%	23.9	112	3569	45.3	194	0.0534	9.6	39.6%	40.0%	20.4%
2009	67.0%	25.0	112	3502	45.1	186	0.0522	9.8	43.0%	39.3%	17.8%
2010	62.7%	25.7	113	3536	45.4	190	0.0528	9.6	42.4%	40.3%	17.3%
2011	57.8%	25.6	115	3617	46.0	200	0.0544	9.5	31.8%	46.5%	21.7%
2012	63.9%	27.3	113	3482	45.3	192	0.0541	9.5	45.0%	40.7%	14.2%

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

Table 2 (continued)

Vehicle Size and Design Characteristics of MY 1975 to 2012 Light Duty Vehicles

Trucks

Model Year	Production Percent	Adj Comp MPG	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time (sec)	Van	Truck SUV	Pickup
1975	19.3%	11.6	4073	-	142	0.0349	13.6	23.1%	9.0%	67.9%
1976	21.1%	12.2	4155	-	141	0.0340	13.8	19.3%	8.9%	71.8%
1977	19.9%	13.3	4136	-	147	0.0356	13.3	18.3%	9.4%	72.2%
1978	22.5%	12.9	4152	-	146	0.0351	13.4	19.2%	11.2%	69.6%
1979	22.1%	12.5	4257	-	138	0.0325	14.3	15.6%	12.5%	71.8%
1980	16.5%	15.8	3869	-	121	0.0313	14.5	13.0%	9.9%	77.1%
1981	17.2%	17.1	3806	-	119	0.0311	14.6	13.5%	7.5%	79.1%
1982	19.5%	17.4	3813	-	120	0.0317	14.5	16.3%	7.9%	75.8%
1983	22.0%	17.7	3773	-	118	0.0313	14.6	16.9%	11.3%	71.8%
1984	23.5%	17.4	3787	-	118	0.0310	14.7	20.6%	17.3%	62.1%
1985	24.8%	17.5	3803	-	124	0.0326	14.1	23.9%	18.1%	58.0%
1986	27.9%	18.2	3741	-	123	0.0330	14.0	24.3%	16.6%	59.0%
1987	27.2%	18.3	3718	-	131	0.0351	13.4	27.6%	19.3%	53.1%
1988	29.1%	17.8	3850	-	141	0.0365	13.0	25.5%	19.3%	55.2%
1989	29.9%	17.6	3932	-	146	0.0371	12.8	29.5%	18.9%	51.6%
1990	29.6%	17.4	4014	-	151	0.0377	12.6	33.8%	17.2%	49.1%
1991	30.4%	17.8	3961	-	150	0.0379	12.5	27.0%	22.8%	50.2%
1992	31.4%	17.3	4078	-	155	0.0380	12.5	32.0%	19.9%	48.1%
1993	32.4%	17.5	4098	-	160	0.0391	12.2	33.7%	19.6%	46.8%
1994	38.1%	17.2	4149	-	166	0.0401	12.0	26.4%	24.0%	49.6%
1995	36.5%	17.0	4201	-	168	0.0400	12.0	30.1%	28.9%	41.1%
1996	37.8%	17.2	4255	-	179	0.0421	11.6	28.4%	32.3%	39.4%
1997	39.9%	16.8	4394	-	189	0.0428	11.4	22.0%	36.3%	41.8%
1998	41.7%	17.1	4317	-	188	0.0435	11.2	24.7%	35.3%	40.0%
1999	41.7%	16.6	4457	-	199	0.0446	11.0	23.0%	36.9%	40.1%
2000	41.2%	16.8	4421	-	199	0.0448	11.0	24.8%	37.0%	38.3%
2001	41.4%	16.5	4543	-	212	0.0465	10.6	19.1%	41.9%	39.0%
2002	44.7%	16.5	4612	-	223	0.0482	10.3	17.2%	49.8%	33.0%
2003	46.1%	16.7	4655	-	224	0.0481	10.4	16.9%	49.1%	34.0%
2004	48.0%	16.5	4783	-	240	0.0500	10.1	12.7%	54.1%	33.3%
2005	44.4%	16.9	4763	-	242	0.0506	10.0	21.0%	46.4%	32.6%
2006	42.1%	17.2	4758	-	240	0.0503	10.0	18.3%	47.3%	34.4%
2007	41.1%	17.4	4871	-	254	0.0519	9.8	13.5%	52.8%	33.7%
2008	40.7%	17.8	4837	54.0	254	0.0522	9.7	14.0%	54.3%	31.7%
2009	33.0%	18.5	4753	54.0	252	0.0527	9.7	12.0%	55.8%	32.2%
2010	37.3%	18.8	4784	53.8	253	0.0526	9.7	13.5%	55.7%	30.8%
2011	42.2%	19.1	4824	54.4	271	0.0557	9.2	10.3%	60.6%	29.2%
2012	36.1%	19.4	4779	54.5	275	0.0571	9.0	14.2%	58.0%	27.7%

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

Table 2 (continued)

Vehicle Size and Design Characteristics of MY 1975 to 2012 Light Duty Vehicles

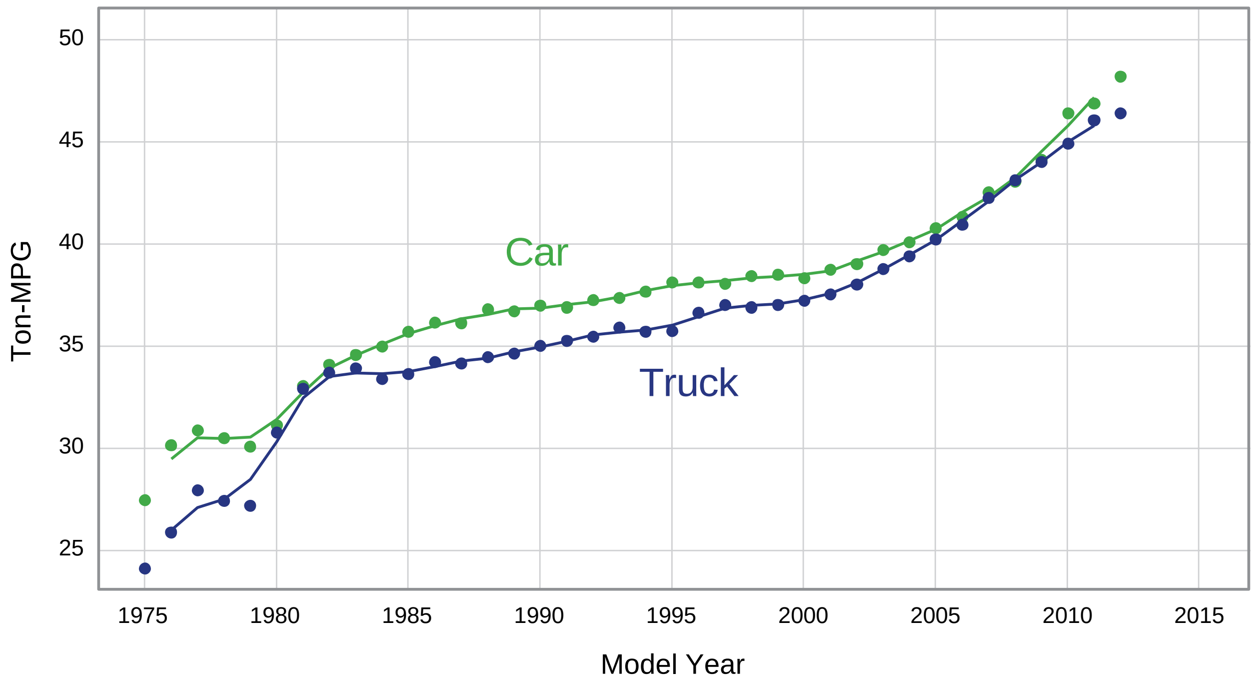
Cars and Trucks

Model Year	Adj Comp MPG	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time (sec)
1975	13.1	4060	-	137	0.0335	14.1
1976	14.2	4079	-	135	0.0328	14.3
1977	15.1	3982	-	136	0.0339	13.8
1978	15.8	3715	-	129	0.0344	13.6
1979	15.9	3655	-	124	0.0335	13.9
1980	19.2	3228	-	104	0.0320	14.3
1981	20.5	3202	-	102	0.0318	14.4
1982	21.1	3202	-	103	0.0320	14.4
1983	21.0	3257	-	107	0.0327	14.1
1984	21.0	3262	-	109	0.0332	14.0
1985	21.3	3271	-	114	0.0347	13.5
1986	21.8	3238	-	114	0.0351	13.4
1987	22.0	3221	-	118	0.0361	13.1
1988	21.9	3283	-	123	0.0372	12.8
1989	21.4	3351	-	129	0.0382	12.5
1990	21.2	3426	-	135	0.0394	12.2
1991	21.3	3410	-	138	0.0402	12.1
1992	20.8	3512	-	145	0.0413	11.8
1993	20.9	3519	-	147	0.0416	11.8
1994	20.4	3603	-	152	0.0420	11.7
1995	20.5	3613	-	158	0.0438	11.3
1996	20.4	3659	-	164	0.0447	11.1
1997	20.2	3727	-	169	0.0452	11.0
1998	20.1	3744	-	171	0.0457	10.9
1999	19.7	3835	-	179	0.0465	10.7
2000	19.8	3821	-	181	0.0472	10.6
2001	19.6	3879	-	187	0.0480	10.5
2002	19.5	3951	-	195	0.0493	10.2
2003	19.6	3999	-	199	0.0496	10.2
2004	19.3	4111	-	211	0.0511	9.9
2005	19.9	4059	-	209	0.0512	9.9
2006	20.1	4067	-	213	0.0522	9.8
2007	20.6	4093	-	217	0.0525	9.7
2008	21.0	4085	48.9	219	0.0529	9.7
2009	22.4	3914	48.1	208	0.0523	9.7
2010	22.6	4002	48.6	214	0.0527	9.6
2011	22.4	4127	49.5	230	0.0550	9.4
2012	23.8	3950	48.6	222	0.0552	9.3

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

Figure 4

Ton-MPG by Model Year
(with Three-Year Moving Average)



Another dramatic long-term trend has been the substantial increase in performance of cars and light trucks as measured by their estimated 0-to-60 mph acceleration time. These trends are shown graphically in Figure 5, which plots fuel economy versus performance for model years since 1975. Both graphs show the same story: in the late 1970s and early 1980s, responding to the regulatory requirements for mpg improvement, the industry increased mpg and kept performance roughly constant. After the regulatory mpg requirements stabilized, mpg improvements ended and performance dramatically improved through 2005 or so. In recent years, both fuel economy and performance have improved.

Figure 6 is similar to Figure 5, but shows the trends in weight and laboratory fuel economy. Weight decreased from the mid-1970s to the mid-1980s, then increased dramatically until about 2005 or so, and has been more stable in recent years.

Figure 5

Laboratory MPG vs. 0-to-60 Time by Model Year

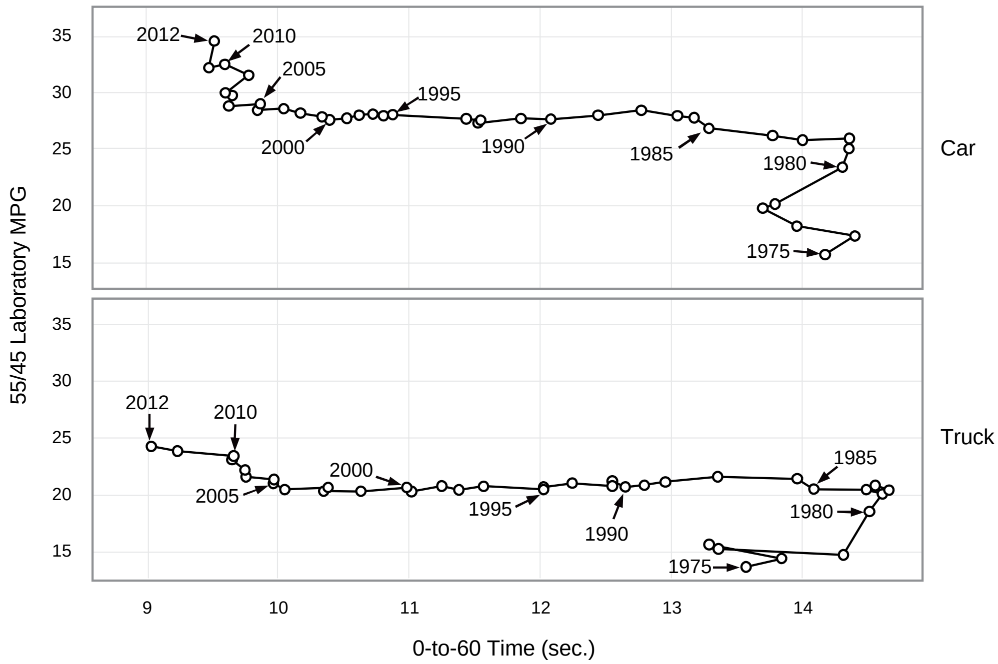
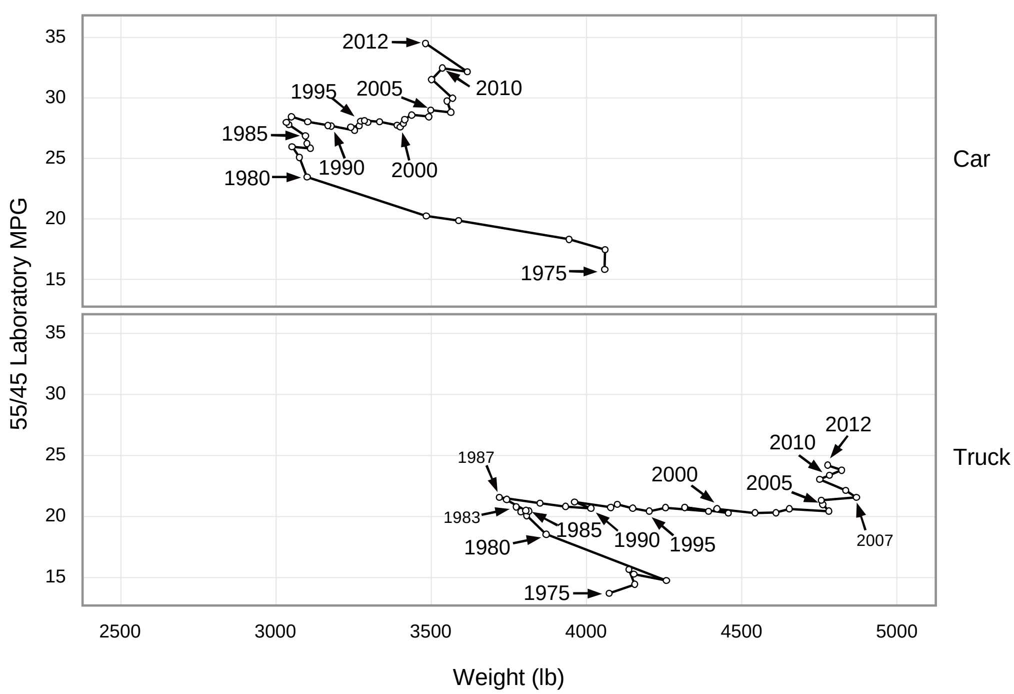


Figure 6

Laboratory MPG vs. Vehicle Weight by Model Year



IV. Carbon Dioxide Emissions Trends

This section focuses on light-duty vehicle tailpipe carbon dioxide (CO_2) emissions data that are measured over the EPA city and highway test procedures. As discussed below, the CO_2 emissions data, along with data for carbon monoxide and hydrocarbon emissions, are used to calculate the vehicle fuel economy levels presented in the rest of this report.

CO_2 is the most important greenhouse gas, responsible for a majority of all global, anthropogenic greenhouse gas emissions. Light-duty vehicles directly emit approximately 17% of total U.S. CO_2 emissions.[2] In April 2007, the U.S. Supreme Court determined that CO_2 is a pollutant under the Clean Air Act[3], and in December 2009, EPA published two findings that CO_2 and other greenhouse gases from new motor vehicles and new motor vehicle engines contribute to air pollution, and that the air pollution may reasonably be anticipated to endanger public health and welfare.[4] In May 2010, EPA published the first-ever light-duty vehicle greenhouse gas emissions standards, under the Clean Air Act, for MY 2012-2016.[5] In October 2012, EPA published greenhouse gas emissions standards for light-duty vehicles for MY 2017-2025.[6] These standards are part of a new, coordinated National Program which also includes CAFE standards that have been established and administered by NHTSA for MY 2012-2021, and augural standards for MY 2022-2025[7]. One of the goals of the National Policy is to establish a coordinated set of greenhouse gas emissions and CAFE standards that automakers can meet with a single national fleet.

Pre-2009 reports in this series presented fuel economy data only and did not include CO_2 emissions data. Beginning with the 2009 report, EPA has added CO_2 emissions data. Rather than adding CO_2 emissions data to all or most of the large number of tables and figures in this report, we are providing a few key summary tables and figures dedicated to CO_2 emissions in this section as well as a methodology with which a reader can convert fuel economy values from other sections of this report to equivalent CO_2 emissions levels. Section III and Sections V through VII of this report, as well as all of the appendices, continue to focus exclusively on fuel economy data.

The light-duty vehicle tailpipe CO_2 emissions data provided in this report represent the sum of three pollutants that EPA and automakers directly measure in the formal emissions certification and fuel economy compliance test programs:

- CO_2 emissions;

- Carbon monoxide emissions, converted to an equivalent CO_2 level on a mass basis by multiplying by a factor of 1.57, which is based on the ratio of molecular weights; and

- Hydrocarbon emissions, converted to an equivalent CO_2 level on a mass basis by multiplying by a factor of approximately 3.17, which is dependent on the measured carbon weight fraction of vehicle test fuel.

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[2] U.S. EPA, 2009, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, EPA 430-R-09-004.
[3] 549 U.S. 497 (2007).
[4] 74 Federal Register 66496 (December 15, 2009).
[5] 75 Federal Register 25324 (May 7, 2010)
[6] 77 Federal Register 62624 (October 15, 2012).
[7] NHTSA CAFE standards fro model years 2022-2025 are not final, and are augural. NHTSA is required by Congress to set CAFE standards for no more than five years at a time. NHTSA will conduct new and full rulemaking in the future to establish standards for model years 2022-2025. NHTSA projects the augural standards would require a combined fleet-wide fuel economy of 48.7-49.7 mpg.

While including the carbon monoxide and hydrocarbon emissions adds, on average, less than one percent to the tailpipe CO_2-equivalent emissions for late model year light-duty vehicles, they are included in the CO_2 emissions values for three reasons:

- Atmospheric processes convert carbon monoxide and hydrocarbons to CO_2 relatively quickly compared to the much longer atmospheric lifetime of CO_2;

- Carbon monoxide and hydrocarbon emissions are included, along with CO_2, in the "carbon balance" equations that EPA uses to calculate fuel economy values, so they must also be included in the CO_2 values to maintain the mathematical integrity of the equations given below to convert between CO_2 emissions and fuel economy values; and

- Including carbon monoxide and hydrocarbon emissions is consistent with EPA's light-duty vehicle CO_2 emissions standard-setting approach.

EPA routinely measures CO_2, carbon monoxide, and hydrocarbon emissions as part of its compliance programs. The individual fuel economy test values that comprise the EPA fuel economy trends database are calculated from a set of "carbon balance" equations based on direct measurement of CO_2, carbon monoxide, and total hydrocarbon emissions. Since carbon is neither created nor destroyed in the combustion process, quantifying the various carbon-containing compounds in the vehicle exhaust as well as the carbon weight fraction of the gasoline test fuel allows the precise calculation of the amount of fuel that was combusted in the vehicle engine. Ironically, while the fuel economy values are calculated from CO_2, carbon monoxide, and hydrocarbon emissions data, the historic EPA fuel economy trends database files do not include the direct emissions data. In order to add CO_2 emissions data to the historical database, EPA has back-calculated the CO_2 emissions (and associated carbon monoxide and hydrocarbon emissions, converted to CO_2 on a mass basis) levels from fuel economy values by reversing the carbon balance equations.

As with the fuel economy data in this report, the light-duty vehicle CO_2 emissions values are expressed in two ways: unadjusted/laboratory values (which will be the basis for CO_2 emissions regulatory compliance beginning in MY 2012) and adjusted/real world values (which are used for consumer information and environmental analysis). The CO_2 emissions values do not represent total light-duty vehicle greenhouse gas emissions, as there are other sources of greenhouse gas emissions beyond the tailpipe CO_2 emissions values. It is also important to note that the tailpipe CO_2 emissions data in this report do not reflect greenhouse gas emissions associated with vehicle assembly, component manufacturing, or vehicle disposal, nor upstream fuel-related production or distribution.

The unadjusted/laboratory CO_2 emissions values are the direct emissions data measured over the EPA city and highway tests. The vehicle air conditioner is turned off during these tests. The EPA city and highway tests will be used for compliance with future EPA light-duty vehicle CO_2 emissions standards (CO_2 standards allow the use of various incentives and credits so that the unadjusted CO_2 tailpipe emissions data in this report will not align with the EPA CO_2 standards or tailpipe compliance values). For late model year vehicles, the unadjusted CO_2 emissions values represent about 90% of total unadjusted light-duty vehicle greenhouse gas emissions. The remaining 10% of total light-duty vehicle greenhouse gas emissions is comprised of air conditioner efficiency-related CO_2 emissions (about 4%), air conditioner hydrofluorocarbon refrigerant emissions leaks (approximately 5%), tailpipe nitrous oxide emissions (about 2%), and tailpipe methane emissions (methane is one hydrocarbon compound with a longer atmospheric lifetime and higher global warming potency, but its mass emissions are so low from gasoline vehicles that its potency-adjusted CO_2-equivalent emissions are about 0.2% of total light-duty vehicle greenhouse gas emissions).[8]

The adjusted CO_2 emissions values are calculated by increasing the unadjusted/laboratory CO_2 emissions test data to account for the many variables that can affect real world vehicle CO_2 emissions. For a detailed discussion of the methodology that EPA uses to convert unadjusted vehicle fuel economy values to adjusted fuel economy values, see Appendix A. This same methodology is used to calculate adjusted CO_2 emissions values as well. On average, based on the current fleet mix, adjusted CO_2 emissions levels are about 25% higher than unadjusted CO_2 values. Because the adjusted CO_2 values take the impact of air conditioner operation on vehicle tailpipe CO_2 emissions into account, adjusted CO_2 values represent about 95% of total adjusted real world light-duty vehicle greenhouse gas emissions, with the remainder composed of air conditioner hydrofluorocarbon refrigerant emissions leaks, tailpipe nitrous oxide emissions, and the higher global warming potency associated with tailpipe methane emissions.

Table 3 gives key light-duty vehicle CO_2 emissions data for the entire data series from 1975 through 2012 for cars only, trucks only, and cars and trucks combined. Table 3 is very similar to Table 1, except that the fuel economy data in Table 1 is replaced with CO_2 emissions data in Table 3.

[8] 75 Federal Register 25421-25425 (May 7, 2010).

Table 3

Carbon Dioxide Emissions of MY 1975 to 2012 Light Duty Vehicles

Cars

Model Year	Production (000)	Production Percent	Lab City CO_2 (g/mi)	Lab Hwy CO_2 (g/mi)	Lab 55/45 CO_2 (g/mi)	Adj City CO_2 (g/mi)	Adj Hwy CO_2 (g/mi)	Adj Comp CO_2 (g/mi)	CO_2/ Ton	CO_2/ Cu Ft	CO_2/ Ton-Cu Ft
1975	8247	80.7%	650	457	563	722	586	661	327	-	-
1976	9734	78.9%	584	418	509	649	536	598	297	-	-
1977	11318	80.1%	556	400	486	618	512	570	290	5.2	2.7
1978	11191	77.5%	516	364	447	574	466	525	294	4.9	2.8
1979	10810	77.9%	503	362	440	559	465	517	298	4.8	2.9
1980	9444	83.5%	439	308	380	488	395	446	289	4.4	2.9
1981	8734	82.8%	412	288	356	458	369	418	273	4.0	2.7
1982	7832	80.5%	401	273	343	445	350	402	264	3.9	2.6
1983	8035	78.0%	402	273	344	447	350	403	259	3.8	2.5
1984	10730	76.5%	397	268	339	441	343	397	256	3.8	2.5
1985	10879	75.2%	388	260	330	431	333	387	250	3.7	2.4
1986	11074	72.1%	375	251	319	420	322	375	247	3.6	2.4
1987	10826	72.8%	373	248	317	420	321	374	247	3.6	2.4
1988	10845	70.9%	367	243	312	416	316	369	243	3.5	2.3
1989	10126	70.1%	375	245	317	426	320	376	243	3.5	2.3
1990	8875	70.4%	380	247	320	435	324	382	241	3.6	2.3
1991	8748	69.6%	379	247	320	437	325	382	242	3.6	2.3
1992	8350	68.6%	387	248	325	448	327	389	240	3.6	2.3
1993	8929	67.6%	383	246	322	447	326	386	239	3.6	2.2
1994	8747	61.9%	383	244	320	449	325	386	237	3.6	2.2
1995	9616	63.5%	380	238	316	448	319	382	234	3.5	2.2
1996	8177	62.2%	381	239	317	452	322	384	234	3.5	2.2
1997	8695	60.1%	378	238	315	452	322	384	234	3.6	2.2
1998	8425	58.3%	380	239	316	456	324	386	232	3.6	2.2
1999	8865	58.3%	384	242	320	464	329	392	231	3.6	2.2
2000	9742	58.8%	385	244	321	468	333	395	233	3.6	2.2
2001	9148	58.6%	380	242	318	466	332	393	231	3.6	2.1
2002	8904	55.3%	375	241	314	462	332	390	229	3.6	2.1
2003	8496	53.9%	370	237	310	460	328	386	225	3.6	2.1
2004	8176	52.0%	373	236	312	466	329	389	223	3.6	2.1
2005	8839	55.6%	365	234	306	459	327	384	220	3.5	2.0
2006	8744	57.9%	368	235	308	463	328	386	217	3.5	2.0
2007	9001	58.9%	355	228	298	448	320	375	211	3.4	1.9
2008	8243	59.3%	352	227	296	445	317	372	209	3.4	1.9
2009	6244	67.0%	334	217	281	423	305	356	203	3.2	1.9
2010	6969	62.7%	323	212	273	411	298	346	196	3.1	1.8
2011	6934	57.8%	329	211	276	417	295	348	193	3.1	1.7
2012	-	63.9%	305	198	257	389	279	326	188	3.0	1.7

Table 3 (continued)

Carbon Dioxide Emissions of MY 1975 to 2012 Light Duty Vehicles

Trucks

Model Year	Production (000)	Production Percent	Lab City CO_2 (g/mi)	Lab Hwy CO_2 (g/mi)	Lab 55/45 CO_2 (g/mi)	Adj City CO_2 (g/mi)	Adj Hwy CO_2 (g/mi)	Adj Comp CO_2 (g/mi)	CO_2/ Ton
1975	1977	19.3%	733	548	650	814	702	764	374
1976	2600	21.1%	692	525	617	769	672	726	349
1977	2805	19.9%	632	490	568	703	628	669	322
1978	3257	22.5%	645	507	583	717	650	687	330
1979	3072	22.1%	663	530	605	737	679	711	333
1980	1863	16.5%	541	407	481	602	521	565	294
1981	1821	17.2%	502	374	444	558	479	523	275
1982	1901	19.5%	497	368	439	552	472	516	272
1983	2267	22.0%	489	356	429	543	456	504	268
1984	3289	23.5%	497	361	436	553	462	512	270
1985	3581	24.8%	495	359	434	550	460	509	267
1986	4291	27.9%	474	343	415	529	442	489	261
1987	4039	27.2%	472	337	411	531	435	486	262
1988	4450	29.1%	485	341	420	548	442	498	259
1989	4327	29.9%	492	345	426	558	449	506	258
1990	3740	29.6%	499	344	429	569	450	512	255
1991	3825	30.4%	487	335	419	559	439	500	253
1992	3822	31.4%	500	340	428	576	447	512	252
1993	4281	32.4%	494	335	422	573	442	507	249
1994	5378	38.1%	501	342	429	584	453	518	250
1995	5529	36.5%	508	344	434	595	457	524	250
1996	4967	37.8%	503	336	428	592	449	518	244
1997	5762	39.9%	510	342	434	603	459	528	241
1998	6030	41.7%	504	335	428	599	451	521	242
1999	6350	41.7%	514	344	438	615	465	535	241
2000	6829	41.2%	504	340	430	606	461	528	240
2001	6458	41.4%	511	347	437	618	472	538	238
2002	7211	44.7%	512	345	437	623	472	539	235
2003	7277	46.1%	505	339	430	618	465	533	230
2004	7533	48.0%	510	341	434	628	469	538	227
2005	7053	44.4%	499	330	423	617	457	526	222
2006	6360	42.1%	489	325	416	607	450	518	218
2007	6275	41.1%	486	321	411	602	444	512	212
2008	5656	40.7%	473	312	401	587	433	499	208
2009	3071	33.0%	454	300	385	565	416	480	203
2010	4141	37.3%	448	296	379	558	410	474	200
2011	5069	42.2%	441	290	373	549	403	466	195
2012	-	36.1%	434	284	366	541	395	458	193

Table 3 (continued)

Carbon Dioxide Emissions of MY 1975 to 2012 Light Duty Vehicles

Cars and Trucks

Model Year	Production (000)	Lab City CO_2 (g/mi)	Lab Hwy CO_2 (g/mi)	Lab 55/45 CO_2 (g/mi)	Adj City CO_2 (g/mi)	Adj Hwy CO_2 (g/mi)	Adj Comp CO_2 (g/mi)	CO_2/ Ton
1975	10224	666	474	580	740	608	681	336
1976	12334	607	440	532	674	565	625	308
1977	14123	571	418	502	635	535	590	296
1978	14448	545	396	478	606	508	562	302
1979	13882	539	399	476	599	512	560	306
1980	11306	456	324	397	507	416	466	290
1981	10554	428	303	371	475	388	436	274
1982	9732	419	292	362	466	374	425	266
1983	10302	421	291	363	468	373	426	261
1984	14020	421	290	362	467	371	424	259
1985	14460	414	284	356	461	364	417	255
1986	15365	403	276	346	450	356	407	251
1987	14865	400	272	343	450	352	405	251
1988	15295	402	272	343	454	353	407	247
1989	14453	410	275	349	466	359	415	247
1990	12615	415	276	353	475	361	420	245
1991	12573	412	274	350	474	360	418	245
1992	12172	423	277	357	488	365	427	243
1993	13211	419	275	354	488	364	426	242
1994	14125	428	281	362	500	374	436	242
1995	15145	426	277	359	501	369	434	240
1996	13144	427	276	359	505	370	435	238
1997	14458	431	280	363	512	376	441	237
1998	14456	431	279	363	516	377	442	236
1999	15215	438	285	369	527	386	451	235
2000	16571	434	283	366	525	386	450	236
2001	15605	434	285	367	529	390	453	234
2002	16115	436	287	369	534	394	457	232
2003	15773	432	284	366	533	391	454	227
2004	15709	439	286	370	544	396	461	225
2005	15892	424	277	358	529	385	447	221
2006	15104	419	273	353	523	380	442	218
2007	15276	409	266	345	511	371	431	212
2008	13898	401	261	338	503	364	424	208
2009	9315	373	244	315	470	341	397	203
2010	11110	370	243	313	465	340	394	197
2011	12003	376	244	317	473	341	398	193
2012	-	352	229	296	444	321	374	190

Figure 7 plots the adjusted CO_2 emissions values over time, for cars only, trucks only, and both cars and trucks combined.

Figure 7

Adjusted CO_2 Emissions by Model Year (grams/mile)

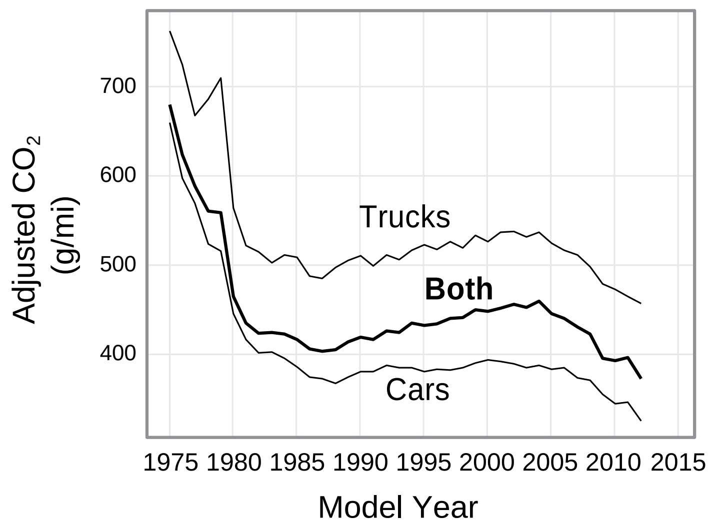


Table 3 and Figure 7 show that, over the last 35 years, adjusted (real world) CO_2 emissions rates have gone through four distinct phases. Most dramatically, adjusted composite (city/highway) CO_2 emissions rates for the combined car/truck fleet fell sharply from 681 grams per mile (g/mi) in MY 1975 to 436 g/mi in MY 1981, for a 36% reduction over 6 years. Adjusted CO_2 emissions continued to decline, though much more slowly, reaching 405 g/mi in MY 1987, which represents a 41% reduction from MY 1975. The trend then reversed, as adjusted CO_2 levels rose slowly over the next 17 years, reaching 461 g/mi in MY 2004, a 14% increase relative to the MY 1987 low. Adjusted CO_2 emissions have been on a generally decreasing trend since 2004, but increased slightly in MY 2011 to 398 g/mi. The preliminary MY 2012 value, based on automaker production projections made prior to the beginning of the model year, is 374 g/mi, which if realized, would be an all-time low.

Laboratory CO_2 emissions values are also given in Table 3. Because laboratory values do not reflect the changes that EPA made to its methodology for adjusting fuel economy and CO_2 emissions levels for real world estimates for consumers, they are the best metric for evaluating CO_2 emissions trends solely on vehicle design considerations. Based on the 55/45 (city/highway) laboratory CO_2 values in Table 3, the MY 2011 value is 317 g/mi and the preliminary MY 2012 value is 296 g/mi, which represents a new all-time low if achieved.

Table 4 shows key light-duty vehicle characteristics, along with the adjusted composite CO_2 emissions values, for the MY 1975 through 2012 timeframe for cars only, trucks only, and cars and trucks combined. Table 4 is very similar to Table 2 discussed above, except that the fuel economy data in Table 2 is replaced with CO_2 emissions data in Table 4.

Table 4

Vehicle Size and Design Characteristics of MY 1975 to 2012 Light Duty Vehicles

Cars

Model Year	Production Percent	Adj Comp CO_2 (g/mi)	Vol (cu ft)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time (sec)	Small	Midsize	Large
1975	80.7%	661	-	4057	-	136	0.0331	14.2	55.4%	23.3%	21.2%
1976	78.9%	598	-	4059	-	134	0.0324	14.4	55.4%	25.2%	19.4%
1977	80.1%	570	110	3944	-	133	0.0335	14.0	52.0%	24.5%	23.5%
1978	77.5%	525	109	3588	-	124	0.0342	13.7	44.7%	34.4%	20.9%
1979	77.9%	517	109	3485	-	119	0.0338	13.8	43.7%	34.2%	22.1%
1980	83.5%	446	104	3101	-	100	0.0322	14.3	54.4%	34.4%	11.3%
1981	82.8%	418	106	3076	-	99	0.0320	14.4	51.5%	36.4%	12.2%
1982	80.5%	402	106	3053	-	99	0.0320	14.4	56.6%	30.9%	12.5%
1983	78.0%	403	109	3112	-	104	0.0330	14.0	53.0%	31.9%	15.0%
1984	76.5%	397	108	3101	-	106	0.0338	13.8	57.1%	29.7%	13.2%
1985	75.2%	387	108	3096	-	111	0.0354	13.3	55.3%	29.5%	15.2%
1986	72.1%	375	107	3043	-	111	0.0360	13.2	59.2%	28.3%	12.5%
1987	72.8%	374	107	3035	-	113	0.0365	13.0	63.2%	24.8%	12.1%
1988	70.9%	369	107	3051	-	116	0.0375	12.8	64.5%	22.8%	12.7%
1989	70.1%	376	108	3104	-	121	0.0387	12.4	58.0%	28.7%	13.4%
1990	70.4%	382	107	3178	-	129	0.0401	12.1	58.4%	28.9%	12.7%
1991	69.6%	382	107	3168	-	133	0.0413	11.9	60.4%	27.6%	12.0%
1992	68.6%	389	109	3254	-	141	0.0427	11.5	55.5%	29.4%	15.2%
1993	67.6%	386	109	3241	-	140	0.0427	11.5	54.7%	32.7%	12.6%
1994	61.9%	386	109	3268	-	144	0.0432	11.4	57.0%	28.2%	14.8%
1995	63.5%	382	109	3274	-	153	0.0460	10.9	56.3%	30.0%	13.7%
1996	62.2%	384	109	3297	-	155	0.0463	10.8	52.9%	33.9%	13.2%
1997	60.1%	384	109	3285	-	156	0.0468	10.7	54.5%	31.7%	13.7%
1998	58.3%	386	109	3334	-	160	0.0473	10.6	47.7%	41.4%	10.8%
1999	58.3%	392	110	3390	-	164	0.0479	10.5	45.8%	42.2%	12.0%
2000	58.8%	395	110	3401	-	168	0.0489	10.4	45.8%	37.1%	17.1%
2001	58.6%	393	110	3411	-	169	0.0491	10.3	48.2%	35.8%	16.0%
2002	55.3%	390	111	3415	-	173	0.0502	10.2	46.6%	39.0%	14.5%
2003	53.9%	386	111	3437	-	176	0.0508	10.0	47.8%	36.9%	15.3%
2004	52.0%	389	112	3492	-	184	0.0520	9.8	44.3%	38.9%	16.8%
2005	55.6%	384	113	3498	-	183	0.0516	9.9	40.6%	40.7%	18.6%
2006	57.9%	386	113	3563	-	194	0.0536	9.6	42.2%	35.8%	22.1%
2007	58.9%	375	113	3551	-	191	0.0530	9.6	40.0%	42.7%	17.3%
2008	59.3%	372	112	3569	45.3	194	0.0534	9.6	39.6%	40.0%	20.4%
2009	67.0%	356	112	3502	45.1	186	0.0522	9.8	43.0%	39.3%	17.8%
2010	62.7%	346	113	3536	45.4	190	0.0528	9.6	42.4%	40.3%	17.3%
2011	57.8%	348	115	3617	46.0	200	0.0544	9.5	31.8%	46.5%	21.7%
2012	63.9%	326	113	3482	45.3	192	0.0541	9.5	45.0%	40.7%	14.2%

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

Table 4 (continued)

Vehicle Size and Design Characteristics of MY 1975 to 2012 Light Duty Vehicles

Trucks

Model Year	Production Percent	Adj Comp CO_2 (g/mi)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time (sec)	Small	Midsize	Large	Van	Truck SUV	Pickup
1975	19.3%	764	4073	-	142	0.0349	13.6	10.6%	24.1%	65.3%	23.1%	9.0%	67.9%
1976	21.1%	726	4155	-	141	0.0340	13.8	8.7%	20.2%	71.0%	19.3%	8.9%	71.8%
1977	19.9%	669	4136	-	147	0.0356	13.3	10.6%	20.4%	69.0%	18.3%	9.4%	72.2%
1978	22.5%	687	4152	-	146	0.0351	13.4	10.6%	22.7%	66.7%	19.2%	11.2%	69.6%
1979	22.1%	711	4257	-	138	0.0325	14.3	14.9%	19.5%	65.6%	15.6%	12.5%	71.8%
1980	16.5%	565	3869	-	121	0.0313	14.5	28.4%	17.6%	54.0%	13.0%	9.9%	77.1%
1981	17.2%	523	3806	-	119	0.0311	14.6	23.2%	19.1%	57.7%	13.5%	7.5%	79.1%
1982	19.5%	516	3813	-	120	0.0317	14.5	20.6%	31.1%	48.2%	16.3%	7.9%	75.8%
1983	22.0%	504	3773	-	118	0.0313	14.6	16.3%	45.6%	38.1%	16.9%	11.3%	71.8%
1984	23.5%	512	3787	-	118	0.0310	14.7	19.7%	45.6%	34.7%	20.6%	17.3%	62.1%
1985	24.8%	509	3803	-	124	0.0326	14.1	19.7%	47.2%	33.1%	23.9%	18.1%	58.0%
1986	27.9%	489	3741	-	123	0.0330	14.0	23.8%	47.8%	28.4%	24.3%	16.6%	59.0%
1987	27.2%	486	3718	-	131	0.0351	13.4	19.8%	59.2%	21.1%	27.6%	19.3%	53.1%
1988	29.1%	498	3850	-	141	0.0365	13.0	14.5%	57.0%	28.5%	25.5%	19.3%	55.2%
1989	29.9%	506	3932	-	146	0.0371	12.8	13.5%	58.7%	27.9%	29.5%	18.9%	51.6%
1990	29.6%	512	4014	-	151	0.0377	12.6	12.9%	57.0%	30.1%	33.8%	17.2%	49.1%
1991	30.4%	500	3961	-	150	0.0379	12.5	10.8%	66.5%	22.7%	27.0%	22.8%	50.2%
1992	31.4%	512	4078	-	155	0.0380	12.5	9.8%	63.0%	27.2%	32.0%	19.9%	48.1%
1993	32.4%	507	4098	-	160	0.0391	12.2	8.7%	62.6%	28.8%	33.7%	19.6%	46.8%
1994	38.1%	518	4149	-	166	0.0401	12.0	9.2%	61.9%	28.9%	26.4%	24.0%	49.6%
1995	36.5%	524	4201	-	168	0.0400	12.0	8.5%	62.5%	29.1%	30.1%	28.9%	41.1%
1996	37.8%	518	4255	-	179	0.0421	11.6	6.1%	66.0%	27.9%	28.4%	32.3%	39.4%
1997	39.9%	528	4394	-	189	0.0428	11.4	8.2%	52.2%	39.7%	22.0%	36.3%	41.8%
1998	41.7%	521	4317	-	188	0.0435	11.2	8.2%	57.0%	34.8%	24.7%	35.3%	40.0%
1999	41.7%	535	4457	-	199	0.0446	11.0	7.3%	53.5%	39.2%	23.0%	36.9%	40.1%
2000	41.2%	528	4421	-	199	0.0448	11.0	5.4%	53.7%	40.9%	24.8%	37.0%	38.3%
2001	41.4%	538	4543	-	212	0.0465	10.6	5.2%	44.4%	50.4%	19.1%	41.9%	39.0%
2002	44.7%	539	4612	-	223	0.0482	10.3	6.1%	40.9%	53.0%	17.2%	49.8%	33.0%
2003	46.1%	533	4655	-	224	0.0481	10.4	5.5%	45.2%	49.3%	16.9%	49.1%	34.0%
2004	48.0%	538	4783	-	240	0.0500	10.1	4.9%	43.4%	51.6%	12.7%	54.1%	33.3%
2005	44.4%	526	4763	-	242	0.0506	10.0	2.6%	46.0%	51.4%	21.0%	46.4%	32.6%
2006	42.1%	518	4758	-	240	0.0503	10.0	2.2%	47.1%	50.7%	18.3%	47.3%	34.4%
2007	41.1%	512	4871	-	254	0.0519	9.8	2.3%	41.7%	56.0%	13.5%	52.8%	33.7%
2008	40.7%	499	4837	54.0	254	0.0522	9.7	3.0%	45.9%	51.2%	14.0%	54.3%	31.7%
2009	33.0%	480	4753	54.0	252	0.0527	9.7	2.6%	48.2%	49.2%	12.0%	55.8%	32.2%
2010	37.3%	474	4784	53.8	253	0.0526	9.7	2.9%	48.0%	49.2%	13.5%	55.7%	30.8%
2011	42.2%	466	4824	54.4	271	0.0557	9.2	-	43.4%	56.6%	10.3%	60.6%	29.2%
2012	36.1%	458	4779	54.5	275	0.0571	9.0	-	42.9%	57.1%	14.2%	58.0%	27.7%

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

Table 4 (continued)

Vehicle Size and Design Characteristics of MY 1975 to 2012 Light Duty Vehicles

Cars and Trucks

Model Year	Adj Comp CO_2 (g/mi)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time (sec)
1975	681	4060	-	137	0.0335	14.1
1976	625	4079	-	135	0.0328	14.3
1977	590	3982	-	136	0.0339	13.8
1978	562	3715	-	129	0.0344	13.6
1979	560	3655	-	124	0.0335	13.9
1980	466	3228	-	104	0.0320	14.3
1981	436	3202	-	102	0.0318	14.4
1982	425	3202	-	103	0.0320	14.4
1983	426	3257	-	107	0.0327	14.1
1984	424	3262	-	109	0.0332	14.0
1985	417	3271	-	114	0.0347	13.5
1986	407	3238	-	114	0.0351	13.4
1987	405	3221	-	118	0.0361	13.1
1988	407	3283	-	123	0.0372	12.8
1989	415	3351	-	129	0.0382	12.5
1990	420	3426	-	135	0.0394	12.2
1991	418	3410	-	138	0.0402	12.1
1992	427	3512	-	145	0.0413	11.8
1993	426	3519	-	147	0.0416	11.8
1994	436	3603	-	152	0.0420	11.7
1995	434	3613	-	158	0.0438	11.3
1996	435	3659	-	164	0.0447	11.1
1997	441	3727	-	169	0.0452	11.0
1998	442	3744	-	171	0.0457	10.9
1999	451	3835	-	179	0.0465	10.7
2000	450	3821	-	181	0.0472	10.6
2001	453	3879	-	187	0.0480	10.5
2002	457	3951	-	195	0.0493	10.2
2003	454	3999	-	199	0.0496	10.2
2004	461	4111	-	211	0.0511	9.9
2005	447	4059	-	209	0.0512	9.9
2006	442	4067	-	213	0.0522	9.8
2007	431	4093	-	217	0.0525	9.7
2008	424	4085	48.9	219	0.0529	9.7
2009	397	3914	48.1	208	0.0523	9.7
2010	394	4002	48.6	214	0.0527	9.6
2011	398	4127	49.5	230	0.0550	9.4
2012	374	3950	48.6	222	0.0552	9.3

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

The manufacturer definitions in this report are those used by NHTSA for purposes of implementation of and manufacturer compliance with the CAFE program. Make is typically included in the model name and is generally recognized by consumers as the “brand” of the vehicle. The Mercury make no longer exists, but is included since Table 5 also includes MY 2010 and 2011. For more details on this vehicle grouping approach, and the thresholds that were used to identify the 11 manufacturers (excluding Hyundai and Kia, as discussed in the Executive Summary) and 26 makes shown in Table 5, see the more detailed discussion in Section VII. It is important to note that when a manufacturer or make grouping is changed to reflect a change in the industry's financial structure, EPA makes the same adjustment in the historical database back to 1975. This maintains a consistent manufacturer (or make) definition over time, which allows a better identification of long-term trends. However, this also means that the current database does not necessarily reflect actual financial or structural arrangements in the past. For example, the 2012 database no longer accounts for the fact that Chrysler was combined with Daimler for several years.

Table 5 gives adjusted CO_2 emissions values for cars, trucks, and cars and trucks combined for MY 2010-2012, for the 11 highest-selling manufacturers (excluding Hyundai and Kia) and 26 largest makes associated with those manufacturers. Manufacturers are listed in order of increasing MY 2011 car plus truck CO_2 emissions rate. By including data from both MY 2010 and MY 2011, with formal end-of-year data for both years, it is possible to identify meaningful changes from year-to-year. Because of the uncertainty associated with the MY 2012 projections, changes from MY 2011 to MY 2012 are less meaningful. EPA anticipates that the MY 2012 results for all manufacturers will change after the final data has been submitted to EPA, and the final MY 2012 data will be included in next year’s report.

Seven of the 11 manufacturers reduced CO_2 emissions in MY 2011. Of these 11 manufacturers, Volkswagen had the lowest MY 2011 adjusted CO_2 emissions performance of 349 g/mi, followed by Mazda at 356 g/mi. Toyota and Honda were tied at 369 g/mi. Daimler had the highest MY 2011 adjusted CO_2 emissions performance for any manufacturer, 469 g/mi, and was followed by Chrysler-Fiat at 458 g/mi and GM at 429 g/mi. In terms of improvement from MY 2010 to MY 2011, Volkswagen had the largest reduction of 14 g/mi, followed by Ford and BMW.

In terms of makes in MY 2011, the Smart had the lowest CO_2 emissions of 243 g/mi. The Daimler Smart Fortwo is the smallest and lightest car in the U.S. market and has very small production volumes. The make with the second-lowest CO_2 emissions performance in MY 2011 is the BMW Mini, which also has relatively low production, at 293 g/mi. Of the makes with higher production for the 11 manufacturers shown in the table, Volkswagen had the lowest CO_2 emissions at 330 g/mi, followed by Scion at 340 g/mi and Mazda at 356 g/mi.

Preliminary projections suggest that all 11 of the manufacturers will improve CO_2 emissions performance further in MY 2012, though EPA will not have actual data for MY 2012 until later this year. Honda, Mazda, Volkswagen, and Toyota are projected to be the overall CO_2 emissions leaders for MY 2011.

Table 5

Adjusted Carbon Dioxide Emissions by Manufacturer and Make for MY 2010-2012 (g/mi)

Manufacturer	Make	2010 Cars	2010 Trucks	2010 Cars and Trucks	2011 Cars	2011 Trucks	2011 Cars and Trucks	2012 Cars	2012 Trucks	2012 Cars and Trucks
VW	VW	338	435	346	318	407	330	325	394	332
VW	Audi	380	463	404	371	423	387	373	422	386
VW	**All**	**349**	**450**	**363**	**333**	**415**	**349**	**336**	**406**	**346**
Mazda	**All**	**344**	**442**	**364**	**338**	**453**	**356**	**330**	**453**	**343**
Toyota	Toyota	287	459	343	308	450	366	279	456	344
Toyota	Lexus	382	422	397	377	437	397	364	427	384
Toyota	Scion	343	-	343	340	-	340	321	-	321
Toyota	**All**	**302**	**453**	**350**	**317**	**449**	**369**	**293**	**453**	**347**
Honda	Honda	314	419	349	315	415	363	295	389	329
Honda	Acura	382	473	413	373	478	434	367	479	408
Honda	**All**	**322**	**425**	**357**	**319**	**422**	**369**	**302**	**398**	**337**
Subaru	**All**	**373**	**382**	**379**	**372**	**371**	**372**	**325**	**371**	**353**
Nissan	Nissan	337	482	378	331	464	374	319	435	353
Nissan	Infiniti	420	554	449	409	522	436	403	513	418
Nissan	**All**	**345**	**487**	**384**	**340**	**469**	**381**	**331**	**439**	**361**
BMW	BMW	422	480	434	398	447	408	395	452	413
BMW	Mini	305	-	305	293	-	293	297	-	297
BMW	**All**	**390**	**480**	**404**	**383**	**447**	**393**	**365**	**452**	**386**
Ford	Ford	362	510	437	352	484	421	317	476	380
Ford	Mercury	387	463	401	414	422	414	-	-	-
Ford	Lincoln	430	470	441	404	503	471	401	505	431
Ford	**All**	**369**	**508**	**435**	**359**	**484**	**422**	**322**	**477**	**382**
GM	Chevrolet	362	498	407	357	501	417	347	495	406
GM	GMC	372	493	465	377	503	475	373	508	471
GM	Buick	420	459	435	397	463	419	366	468	382
GM	Cadillac	438	527	449	433	570	456	434	567	478
GM	**All**	**374**	**494**	**418**	**371**	**501**	**429**	**354**	**499**	**415**
Chrysler-Fiat	Jeep	-	484	484	-	465	465	-	468	468
Chrysler-Fiat	Dodge	401	461	428	391	460	431	383	444	418
Chrysler-Fiat	Chrysler	398	452	430	386	428	405	380	425	402
Chrysler-Fiat	Ram	-	556	556	-	554	554	-	538	538
Chrysler-Fiat	**All**	**402**	**482**	**455**	**392**	**477**	**458**	**362**	**464**	**431**
Daimler	Mercedes-Benz	451	522	474	444	533	472	392	506	418
Daimler	Smart	241	-	241	243	-	243	244	-	244
Daimler	**All**	**446**	**522**	**471**	**440**	**533**	**469**	**392**	**506**	**418**
Other	**All**	**386**	**510**	**433**	**373**	**493**	**423**	**379**	**463**	**403**
Fleet		**346**	**474**	**394**	**348**	**466**	**398**	**326**	**458**	**374**

*Note: Two manufacturers, Hyundai and Kia, are not included in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. This report uses the corrected fuel economy values submitted by Hyundai and Kia for four MY 2011 vehicles and for a majority of Hyundai and Kia vehicles for MY 2012. Based on these corrected data, Hyundai's 2010 Cars and Trucks value is 329 g/mi CO_2, Hyundai's 2011 Cars and Trucks value is 327 g/mi CO_2, Hyundai's preliminary 2012 Cars and Trucks value is 309 g/mi CO_2, Kia's 2010 Cars and Trucks value is 330 g/mi CO_2, Kia's 2011 Cars and Truck values is 345 g/mi CO_2, and Kia's preliminary 2012 Car and truck value is 333 g/mi CO_2.

While Tables 3, 4, and 5 provide key summary CO_2 emissions data, EPA recognizes that many users will want the CO_2 emissions values equivalent to the fuel economy values in many other tables in this report. Converting fuel economy values from tables in this report to approximate equivalent CO_2 emissions values is fairly straightforward.

If it is known that a fuel economy value in this report is based on a single gasoline vehicle, or a 100% gasoline vehicle fleet, one can calculate the precise corresponding CO_2 value by simply dividing 8887 (which is a typical value for the grams of CO_2 per gallon of gasoline test fuel, assuming all the carbon is converted to CO_2) by the fuel economy value in miles per gallon. For example, 8887 divided by a gasoline vehicle fuel economy of 30 mpg would yield an equivalent CO_2 emissions value of 296 grams per mile.

Since gasoline vehicle production has accounted for 99+% of all light-duty vehicle production for all model years since 1975 except for the six years from 1979 through 1984, this simple approach yields very accurate results for most model years.

Diesel fuel has 14.5% higher carbon content per gallon than gasoline. To calculate a CO_2 equivalent value for a diesel vehicle, one should divide 10,180 by the diesel vehicle fuel economy value. Accordingly, a 30 mpg diesel vehicle would have a CO_2 equivalent value of 339 grams per mile.

Table 6 should be used by those who want to make the most accurate conversions of industry-wide fuel economy values to CO_2 emissions values. Table 6 gives model year-specific industry-wide values for grams of CO_2 per gallon based on actual light-duty gasoline and diesel vehicle production in that year. Using these model year-specific values and dividing by the fuel economy value in miles per gallon will allow accurate conversions of industry-wide fuel economy values to industry-wide CO_2 emissions values.

Readers will have to make judgment calls about how to best convert fuel economy values that do not represent industry-wide values (e.g., just small cars or vehicles with 5-speed automatic transmissions). If the user knows the gasoline/diesel production volume fractions of the individual database component, it is best to generate a weighted value of grams of CO_2 per gallon based on the 8887 (gasoline) and 10,180 (diesel) factors discussed above. Otherwise, the reader can choose between the model year-specific weighting in Table 6 (which implicitly assumes that the diesel fraction in the database component of interest is similar to that for the overall fleet in that year) or the gasoline value of 8887 (implicitly assuming no diesels in that database component). In nearly all cases, any error associated with either of these approaches will be relatively small.

Table 6

Factors for Converting Industry-wide Fuel Economy Values from this Report to Carbon Dioxide Emissions Values

Model Year	Gasoline Production Share	Diesel Production Share	Weighted CO_2 per Gallon (grams)
1975	99.8%	0.2%	8890
1976	99.8%	0.2%	8890
1977	99.6%	0.4%	8892
1978	99.1%	0.9%	8899
1979	98.0%	2.0%	8913
1980	95.7%	4.3%	8943
1981	94.1%	5.9%	8963
1982	94.4%	5.6%	8959
1983	97.3%	2.7%	8922
1984	98.2%	1.8%	8910
1985	99.1%	0.9%	8899
1986	99.6%	0.4%	8892
1987	99.7%	0.3%	8891
1988	99.9%	0.1%	8888
1989	99.9%	0.1%	8888
1990	99.9%	0.1%	8888
1991	99.9%	0.1%	8888
1992	99.9%	0.1%	8888
1993	100.0%	-	8887
1994	100.0%	0.0%	8887
1995	100.0%	0.0%	8887
1996	99.9%	0.1%	8888
1997	99.9%	0.1%	8888
1998	99.9%	0.1%	8888
1999	99.9%	0.1%	8888
2000	99.9%	0.1%	8888
2001	99.9%	0.1%	8888
2002	99.8%	0.2%	8890
2003	99.8%	0.2%	8890
2004	99.9%	0.1%	8888
2005	99.7%	0.3%	8891
2006	99.6%	0.4%	8892
2007	99.9%	0.1%	8888
2008	99.9%	0.1%	8888
2009	99.5%	0.5%	8893
2010	99.3%	0.7%	8896
2011	99.2%	0.8%	8897
2012	99.2%	0.8%	8897

V. Fuel Economy Trends by Vehicle Type, Size, and Weight

Figure 8 shows production share trends by vehicle type. Of the six vehicle classes shown—cars, wagons, non-truck SUVs, truck SUVs, vans, and pickups—the biggest overall increase in production share since 1975 has been for the two categories of SUVs, which, combined, increased from less than two percent in MY 1975 to nearly 30% in MY 2012. The biggest overall decrease has been for cars, down from 71% of the fleet in MY 1975 to about 50% in MY 2012.

Figure 9 (size within vehicle type) and Table 7 (across the entire market) compares production fractions by vehicle type and size with the fleet again stratified into six vehicle types (cars, station wagons, non-truck SUVs, vans, truck SUVs, and pickup trucks) and three vehicle sizes (small, midsize, and large). Small cars have historically been the leading segment, but midsize cars now have a similar share. Wagons have decreased from about 10% of production in MY 1975 to about 3% of production today, almost exclusively small wagons.

Since 1975, the largest increases in production fractions have been for SUVs. Truck SUVs and non-truck SUVs (those now classified as cars for regulatory purposes) are expected to account for nearly 30% of all light vehicles sold in MY 2012, compared to combined totals of about 2% in MY 1975 and 6% in MY 1988, respectively. Minivans and vans, whose popularity peaked in the 1990s, now account for about 5% of production, similar to MY 1975 levels. Almost all of the vans sold today are midsize minivans. Pickups are now almost exclusively large pickups.

Figure 8

Production Share by Vehicle Type

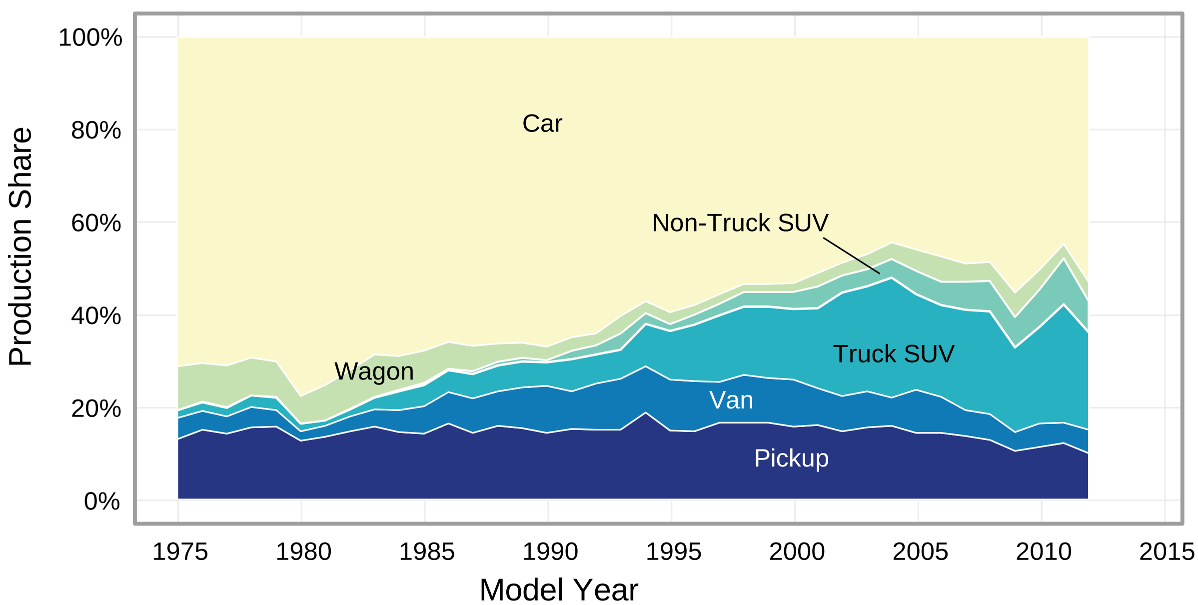


Figure 9

Production Share by Vehicle Size

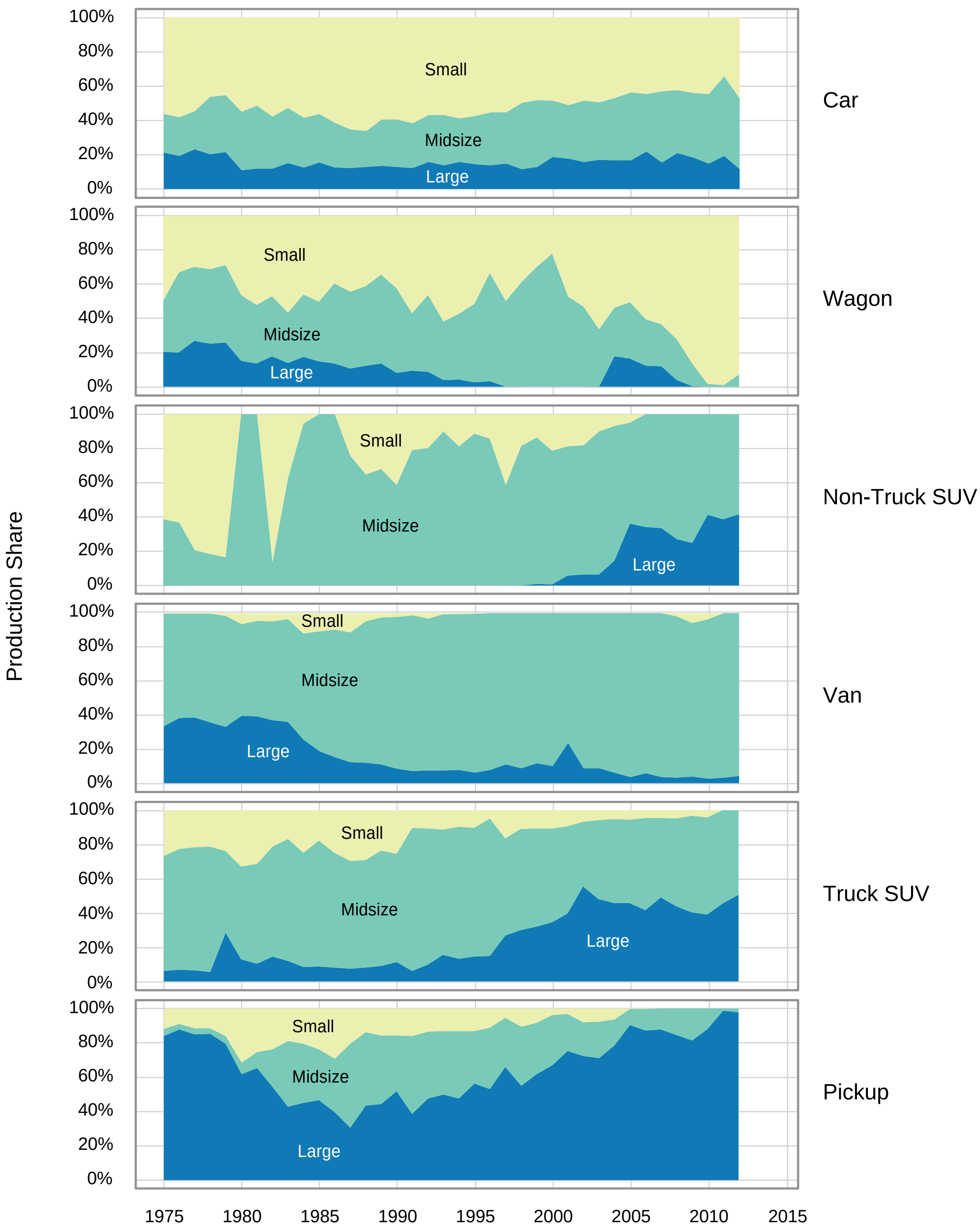


Table 7

Production Shares of MY 1975, 1988, and 2012 by Vehicle Size and Type

Vehicle Type	Size	1975	1988	2012	Difference 1975 to 2012	Difference 1975 to 1988	Difference 1988 to 2012
Car	Small	40.0%	43.8%	25.1%	-14.9%	3.9%	-18.7%
Car	Midsize	16.0%	13.8%	21.7%	5.8%	-2.1%	7.9%
Car	Large	15.2%	8.5%	6.2%	-9.0%	-6.7%	-2.3%
Car	All	71.1%	66.2%	53.1%	-18.0%	-5.0%	-13.1%
Wagon	Small	4.7%	1.7%	3.6%	-1.0%	-3.0%	2.0%
Wagon	Midsize	2.8%	1.9%	0.3%	-2.5%	-1.0%	-1.6%
Wagon	Large	1.9%	0.5%	-	-1.9%	-1.4%	-0.5%
Wagon	All	9.4%	4.0%	3.9%	-5.5%	-5.4%	-0.1%
Non-Truck SUV	Small	0.1%	0.3%	-	-0.1%	0.2%	-0.3%
Non-Truck SUV	Midsize	0.0%	0.5%	4.0%	4.0%	0.4%	3.5%
Non-Truck SUV	Large	-	-	2.9%	2.9%	-	2.9%
Non-Truck SUV	All	0.1%	0.7%	6.8%	6.7%	0.6%	6.1%
Van	Small	0.0%	0.4%	-	0.0%	0.3%	-0.4%
Van	Midsize	3.0%	6.2%	4.9%	2.0%	3.2%	-1.2%
Van	Large	1.5%	0.9%	0.2%	-1.3%	-0.6%	-0.7%
Van	All	4.5%	7.4%	5.1%	0.7%	2.9%	-2.3%
Truck SUV	Small	0.5%	1.6%	-	-0.5%	1.2%	-1.6%
Truck SUV	Midsize	1.2%	3.5%	10.3%	9.2%	2.4%	6.8%
Truck SUV	Large	0.1%	0.5%	10.6%	10.5%	0.3%	10.2%
Truck SUV	All	1.7%	5.6%	21.0%	19.2%	3.9%	15.3%
Pickup	Small	1.6%	2.2%	-	-1.6%	0.7%	-2.2%
Pickup	Midsize	0.5%	6.9%	0.2%	-0.3%	6.3%	-6.7%
Pickup	Large	11.0%	7.0%	9.8%	-1.2%	-4.1%	2.8%
Pickup	All	13.1%	16.1%	10.0%	-3.1%	2.9%	-6.1%
All Trucks		19.3%	29.1%	36.1%	16.8%	9.8%	7.0%

Figure 10 shows annual trends in adjusted fuel economy, weight, and performance for cars, wagons, non-truck SUVs, vans, truck SUVs, and pickups. For all six vehicle types, the recent trends, since 2005, have been increasing fuel economy, fairly stable weight, and decreasing 0-60 acceleration time (or increased performance).

Table 8 shows the lowest, average, and highest adjusted mpg performance by vehicle type and size for three selected years. For both MY 1988 and 2012, the mpg performance is such that the midsize vehicles in all vehicle type/size combinations have better fuel economy than the corresponding entry for small vehicles in 1975. In Table 9, the percentage changes obtainable from the entries in Table 8 are presented. Average mpg for several vehicle type/size combinations has more than doubled since 1975. Tables 10 and 11 present this same data in terms of fuel consumption.

Figure 10

Fuel Economy and Performance by Vehicle Type

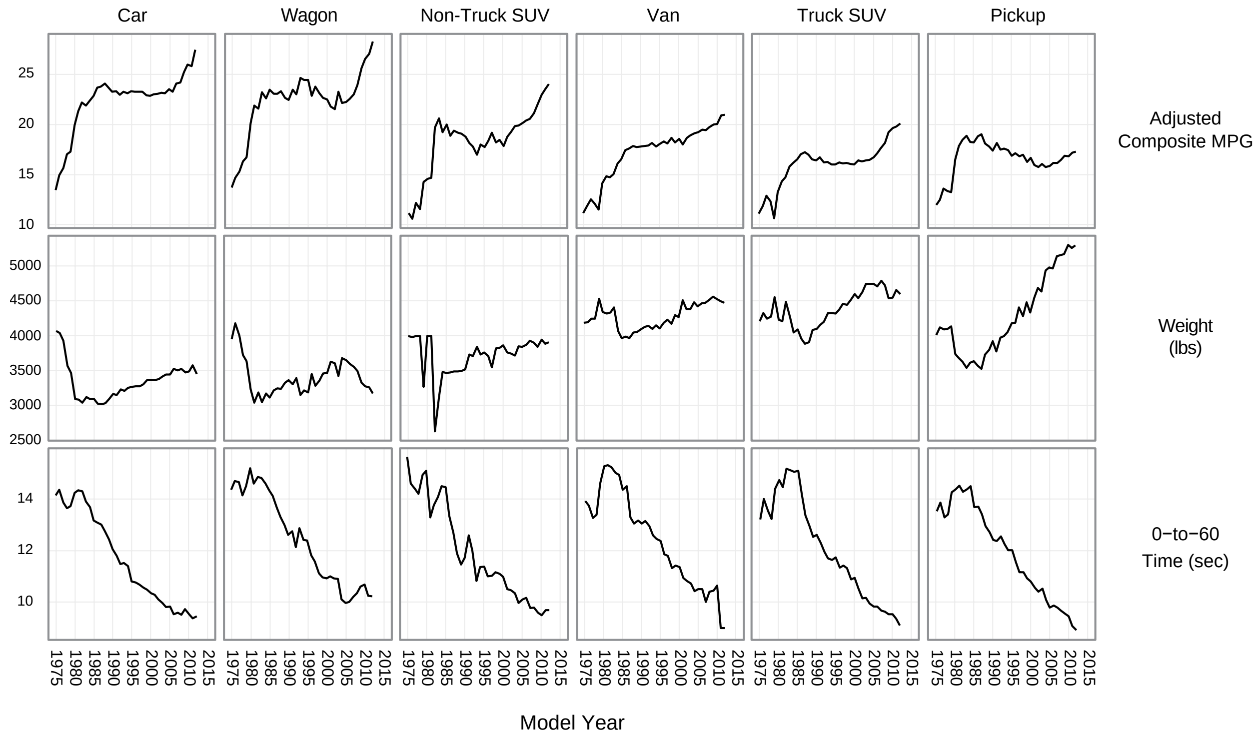


Table 8

Lowest, Average, and Highest Adjusted Fuel Economy by Vehicle Type and Size

Car or Truck	Vehicle Type	Size	1975 Low	1975 Average	1975 High	1988 Low	1988 Average	1988 High	2012 Low	2012 Average	2012 High
Car	Car	Small	8.6	15.6	28.3	7.5	25.7	54.4	11.2	28.8	48.8
Car	Car	Midsize	8.6	11.6	18.4	10.5	22.6	27.7	13.3	27.5	49.3
Car	Car	Large	8.4	11.2	14.6	10.0	20.6	26.0	12.7	24.2	28.9
Car	Car	All	8.4	13.4	28.3	7.5	24.2	54.4	11.2	27.7	49.3
Car	Wagon	Small	11.8	19.1	24.1	17.1	26.3	33.2	14.9	27.5	35.6
Car	Wagon	Midsize	8.4	11.3	25.0	17.5	22.2	27.7	19.1	40.4	41.6
Car	Wagon	Large	8.4	10.2	12.8	19.2	19.4	19.4	-	-	-
Car	Wagon	All	8.4	13.8	25.0	17.1	23.3	33.2	14.9	28.2	41.6
Car	Non-Truck SUV	Small	10.2	10.2	10.2	18.6	19.4	20.3	-	-	-
Car	Non-Truck SUV	Midsize	11.1	12.9	18.4	17.2	19.2	23.6	18.9	24.3	31.9
Car	Non-Truck SUV	Large	-	-	-	-	-	NA	18.3	23.9	27.0
Car	Non-Truck SUV	All	10.2	11.1	18.4	17.2	19.2	23.6	18.3	24.1	31.9
Truck	Van	Small	16.2	17.5	18.5	15.5	20.6	25.0	-	-	-
Truck	Van	Midsize	8.2	11.3	18.4	11.3	18.4	23.4	15.1	21.4	24.2
Truck	Van	Large	8.9	10.7	14.5	10.0	14.3	16.8	11.5	15.3	17.4
Truck	Van	All	8.2	11.1	18.5	10.0	17.9	25.0	11.5	21.1	24.2
Truck	Truck SUV	Small	12.8	14.3	16.3	15.6	20.5	27.8	-	-	-
Truck	Truck SUV	Midsize	8.2	10.2	16.7	10.2	16.2	22.4	14.3	21.9	28.5
Truck	Truck SUV	Large	7.9	10.3	13.7	12.2	14.0	18.8	12.7	18.8	25.0
Truck	Truck SUV	All	7.9	11.0	16.7	10.2	17.0	27.8	12.7	20.2	28.5
Truck	Pickup	Small	13.0	19.2	20.8	13.3	21.0	24.6	-	-	-
Truck	Pickup	Midsize	17.8	17.9	18.0	15.3	21.3	25.9	17.7	21.1	21.8
Truck	Pickup	Large	7.6	11.1	18.5	9.8	15.2	21.0	13.6	17.2	22.7
Truck	Pickup	All	7.6	11.9	20.8	9.8	18.1	25.9	13.6	17.3	22.7
Car	All	All	8.4	13.5	28.3	7.5	24.1	54.4	11.2	27.3	49.3
Truck	All	All	7.6	11.6	20.8	9.8	17.8	27.8	11.5	19.4	28.5
Fleet	All	All	7.6	13.1	28.3	7.5	21.9	54.4	11.2	23.8	49.3

Table 9

Percent Change in Lowest, Average, and Highest Adjusted Fuel Economy by Vehicle Type and Size

Car or Truck	Vehicle Type	Size	1975 to 2012 Low	1975 to 2012 Average	1975 to 2012 High	1975 to 1988 Low	1975 to 1988 Average	1975 to 1988 High	1988 to 2012 Low	1988 to 2012 Average	1988 to 2012 High
Car	Car	Small	30%	85%	72%	-13%	65%	92%	49%	12%	-10%
Car	Car	Midsize	55%	137%	168%	22%	95%	51%	27%	22%	78%
Car	Car	Large	51%	116%	98%	19%	84%	78%	27%	17%	11%
Car	Car	All	33%	107%	74%	-11%	81%	92%	49%	14%	-9%
Car	Wagon	Small	26%	44%	48%	45%	38%	38%	-13%	5%	7%
Car	Wagon	Midsize	127%	258%	66%	108%	96%	11%	9%	82%	50%
Car	Wagon	Large	-	-	-	129%	90%	52%	-	-	-
Car	Wagon	All	77%	104%	66%	104%	69%	33%	-13%	21%	25%
Car	Non-Truck SUV	Small	-	-	-	82%	90%	99%	-	-	-
Car	Non-Truck SUV	Midsize	70%	88%	73%	55%	49%	28%	10%	27%	35%
Car	Non-Truck SUV	Large	-	-	-	-	-	-	-	-	-
Car	Non-Truck SUV	All	79%	117%	73%	69%	73%	28%	6%	26%	35%
Truck	Van	Small	-	-	-	-4%	18%	35%	-	-	-
Truck	Van	Midsize	84%	89%	32%	38%	63%	27%	34%	16%	3%
Truck	Van	Large	29%	43%	20%	12%	34%	16%	15%	7%	4%
Truck	Van	All	40%	90%	31%	22%	61%	35%	15%	18%	-3%
Truck	Truck SUV	Small	-	-	-	22%	43%	71%	-	-	-
Truck	Truck SUV	Midsize	74%	115%	71%	24%	59%	34%	40%	35%	27%
Truck	Truck SUV	Large	61%	83%	82%	54%	36%	37%	4%	34%	33%
Truck	Truck SUV	All	61%	84%	71%	29%	55%	66%	25%	19%	3%
Truck	Pickup	Small	-	-	-	2%	9%	18%	-	-	-
Truck	Pickup	Midsize	-1%	18%	21%	-14%	19%	44%	16%	-1%	-16%
Truck	Pickup	Large	79%	55%	23%	29%	37%	14%	39%	13%	8%
Truck	Pickup	All	79%	45%	9%	29%	52%	25%	39%	-4%	-12%
Car	All	All	33%	102%	74%	-11%	79%	92%	49%	13%	-9%
Truck	All	All	51%	67%	37%	29%	53%	34%	17%	9%	3%
Fleet	All	All	47%	82%	74%	-1%	67%	92%	49%	9%	-9%

Table 10

Adjusted Fuel Consumption (Gal./100 miles) by Vehicle Type and Size

Car or Truck	Vehicle Type	Size	1975 High	1975 Average	1975 Low	1988 High	1988 Average	1988 Low	2012 High	2012 Average	2012 Low
Car	Car	Small	11.6	6.4	3.5	13.3	3.9	1.8	8.9	3.5	2.0
Car	Car	Midsize	11.6	8.6	5.4	9.5	4.4	3.6	7.5	3.6	2.0
Car	Car	Large	11.9	8.9	6.8	10.0	4.9	3.8	7.9	4.1	3.5
Car	Car	All	11.9	7.5	3.5	13.3	4.1	1.8	8.9	3.6	2.0
Car	Wagon	Small	8.5	5.2	4.1	5.8	3.8	3.0	6.7	3.6	2.8
Car	Wagon	Midsize	11.9	8.8	4.0	5.7	4.5	3.6	5.2	2.5	2.4
Car	Wagon	Large	11.9	9.8	7.8	5.2	5.2	5.2	-	-	-
Car	Wagon	All	11.9	7.2	4.0	5.8	4.3	3.0	6.7	3.5	2.4
Car	Non-Truck SUV	Small	9.8	9.8	9.8	5.4	5.2	4.9	-	-	-
Car	Non-Truck SUV	Midsize	9.0	7.8	5.4	5.8	5.2	4.2	5.3	4.1	3.1
Car	Non-Truck SUV	Large	-	-	-	-	-	-	5.5	4.2	3.7
Car	Non-Truck SUV	All	9.8	9.0	5.4	5.8	5.2	4.2	5.5	4.1	3.1
Truck	Van	Small	6.2	5.7	5.4	6.5	4.9	4.0	-	-	-
Truck	Van	Midsize	12.2	8.8	5.4	8.8	5.4	4.3	6.6	4.7	4.1
Truck	Van	Large	11.2	9.3	6.9	10.0	7.0	6.0	8.7	6.5	5.7
Truck	Van	All	12.2	9.0	5.4	10.0	5.6	4.0	8.7	4.7	4.1
Truck	Truck SUV	Small	7.8	7.0	6.1	6.4	4.9	3.6	-	-	-
Truck	Truck SUV	Midsize	12.2	9.8	6.0	9.8	6.2	4.5	7.0	4.6	3.5
Truck	Truck SUV	Large	12.7	9.7	7.3	8.2	7.1	5.3	7.9	5.3	4.0
Truck	Truck SUV	All	12.7	9.1	6.0	9.8	5.9	3.6	7.9	5.0	3.5
Truck	Pickup	Small	7.7	5.2	4.8	7.5	4.8	4.1	-	-	-
Truck	Pickup	Midsize	5.6	5.6	5.6	6.5	4.7	3.9	5.6	4.7	4.6
Truck	Pickup	Large	13.2	9.0	5.4	10.2	6.6	4.8	7.4	5.8	4.4
Truck	Pickup	All	13.2	8.4	4.8	10.2	5.5	3.9	7.4	5.8	4.4
Car	All	All	11.9	7.4	3.5	13.3	4.1	1.8	8.9	3.7	2.0
Truck	All	All	13.2	8.6	4.8	10.2	5.6	3.6	8.7	5.2	3.5
Fleet	All	All	13.2	7.6	3.5	13.3	4.6	1.8	8.9	4.2	2.0

Table 11

Percent Change* in Adjusted Fuel Consumption by Vehicle Type and Size

Car or Truck	Vehicle Type	Size	1975 to 2012 High	1975 to 2012 Average	1975 to 2012 Low	1975 to 1988 High	1975 to 1988 Average	1975 to 1988 Low	1988 to 2012 High	1988 to 2012 Average	1988 to 2012 Low
Car	Car	Small	23%	45%	43%	-15%	39%	49%	33%	10%	-11%
Car	Car	Midsize	35%	58%	63%	18%	49%	33%	21%	18%	44%
Car	Car	Large	34%	54%	49%	16%	45%	44%	21%	16%	8%
Car	Car	All	25%	52%	43%	-12%	45%	49%	33%	12%	-11%
Car	Wagon	Small	21%	31%	32%	32%	27%	27%	-16%	5%	7%
Car	Wagon	Midsize	56%	72%	40%	52%	49%	10%	9%	44%	33%
Car	Wagon	Large	-	-	-	56%	47%	33%	-	-	-
Car	Wagon	All	44%	51%	40%	51%	40%	25%	-16%	19%	20%
Car	Non-Truck SUV	Small	-	-	-	45%	47%	50%	-	-	-
Car	Non-Truck SUV	Midsize	41%	47%	43%	36%	33%	22%	9%	21%	26%
Car	Non-Truck SUV	Large	-	-	-	-	-	-	-	-	-
Car	Non-Truck SUV	All	44%	54%	43%	41%	42%	22%	5%	21%	26%
Truck	Van	Small	-	-	-	-5%	14%	26%	-	-	-
Truck	Van	Midsize	46%	47%	24%	28%	39%	20%	25%	13%	5%
Truck	Van	Large	22%	30%	17%	11%	25%	13%	13%	7%	5%
Truck	Van	All	29%	48%	24%	18%	38%	26%	13%	16%	-2%
Truck	Truck SUV	Small	-	-	-	18%	30%	41%	-	-	-
Truck	Truck SUV	Midsize	43%	53%	42%	20%	37%	25%	29%	26%	22%
Truck	Truck SUV	Large	38%	45%	45%	35%	27%	27%	4%	25%	25%
Truck	Truck SUV	All	38%	45%	42%	23%	35%	40%	19%	15%	3%
Truck	Pickup	Small	-	-	-	3%	8%	15%	-	-	-
Truck	Pickup	Midsize	0%	16%	18%	-16%	16%	30%	14%	0%	-18%
Truck	Pickup	Large	44%	36%	19%	23%	27%	11%	27%	12%	8%
Truck	Pickup	All	44%	31%	8%	23%	35%	19%	27%	-5%	-13%
Car	All	All	25%	50%	43%	-12%	45%	49%	33%	10%	-11%
Truck	All	All	34%	40%	27%	23%	35%	25%	15%	7%	3%
Fleet	All	All	33%	45%	43%	-1%	39%	49%	33%	9%	-11%

*Note: A negative change indicates that fuel consumption has increased.

Cars and light trucks with conventional drive trains have a fuel consumption and weight relationship which is well known and is shown in Figure 11. Fuel consumption increases linearly with weight. Because vehicles with different propulsion systems (i.e., diesels and hybrids) occupy a different place on such a fuel consumption and weight plot, the data for hybrid and diesel vehicles are plotted separately and excluded from the trend lines shown on the graphs. At constant weight, MY 2012 cars consume about 40% less fuel per mile than their MY 1975 counterparts.

On this same constant weight basis, this year's vehicles with diesel engines consume 20-30% less fuel than the conventionally powered ones, while this year's hybrid vehicles are about 20-60% better. Similarly, at constant weight this year's conventionally powered trucks achieve about 50% better fuel consumption than MY 1975 vehicles did.

Figure 11

Laboratory 55/45 Fuel Consumption vs. Vehicle Weight, MY 1975 and MY 2012

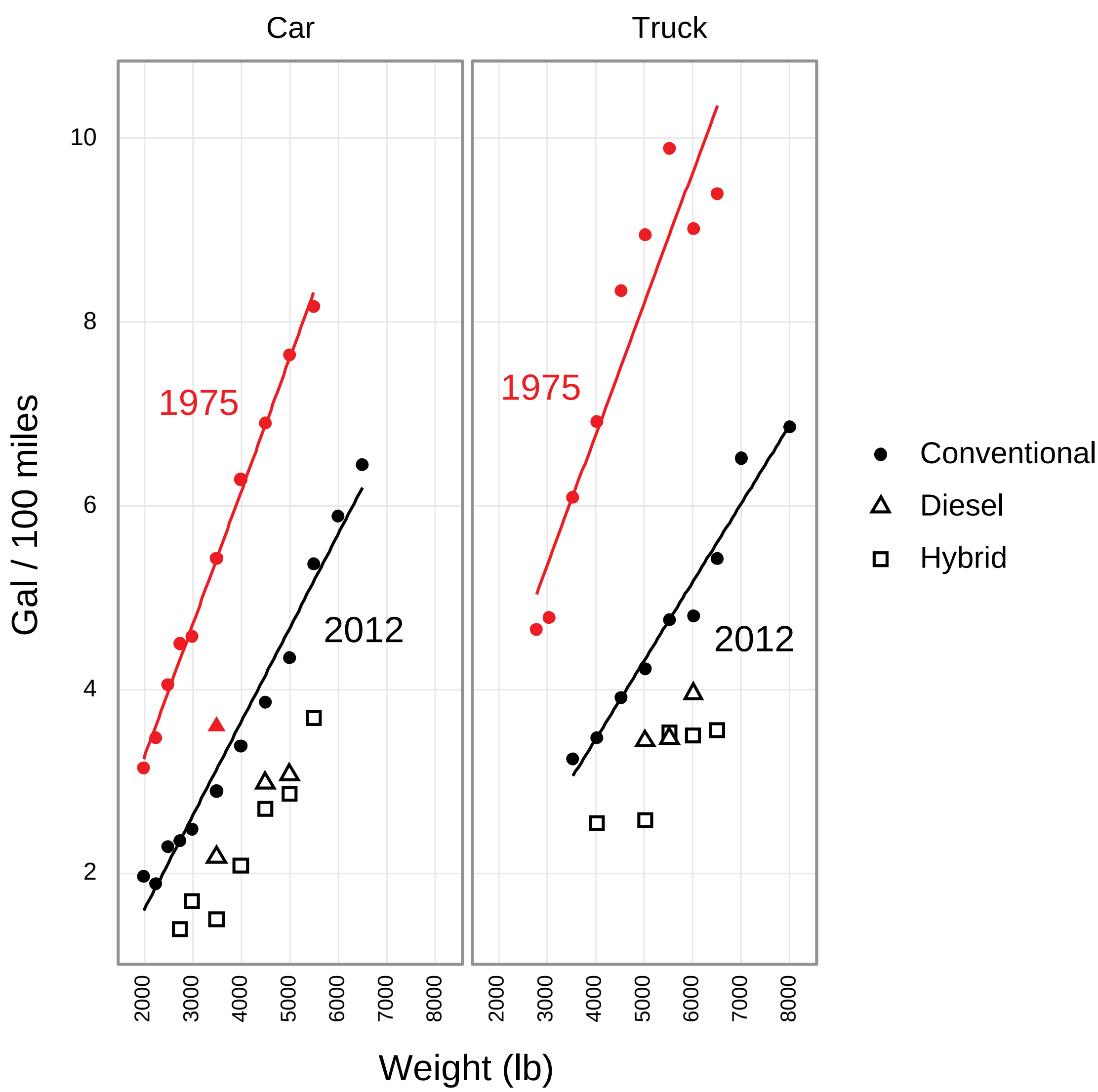


Figure 12 shows that the relationship between interior volume and fuel consumption is currently not as important as in the past. The data points on both of these graphs exclude two seaters and represent production weighted average fuel consumption calculated at increments of 1.0 cu. ft. As was done for Figure 11, the data points for hybrid and diesel vehicles were plotted separately from those for the conventionally powered vehicles.

Figure 12

Laboratory 55/45 Fuel Consumption vs. Interior Volume, MY 1978 and MY 2012 Cars

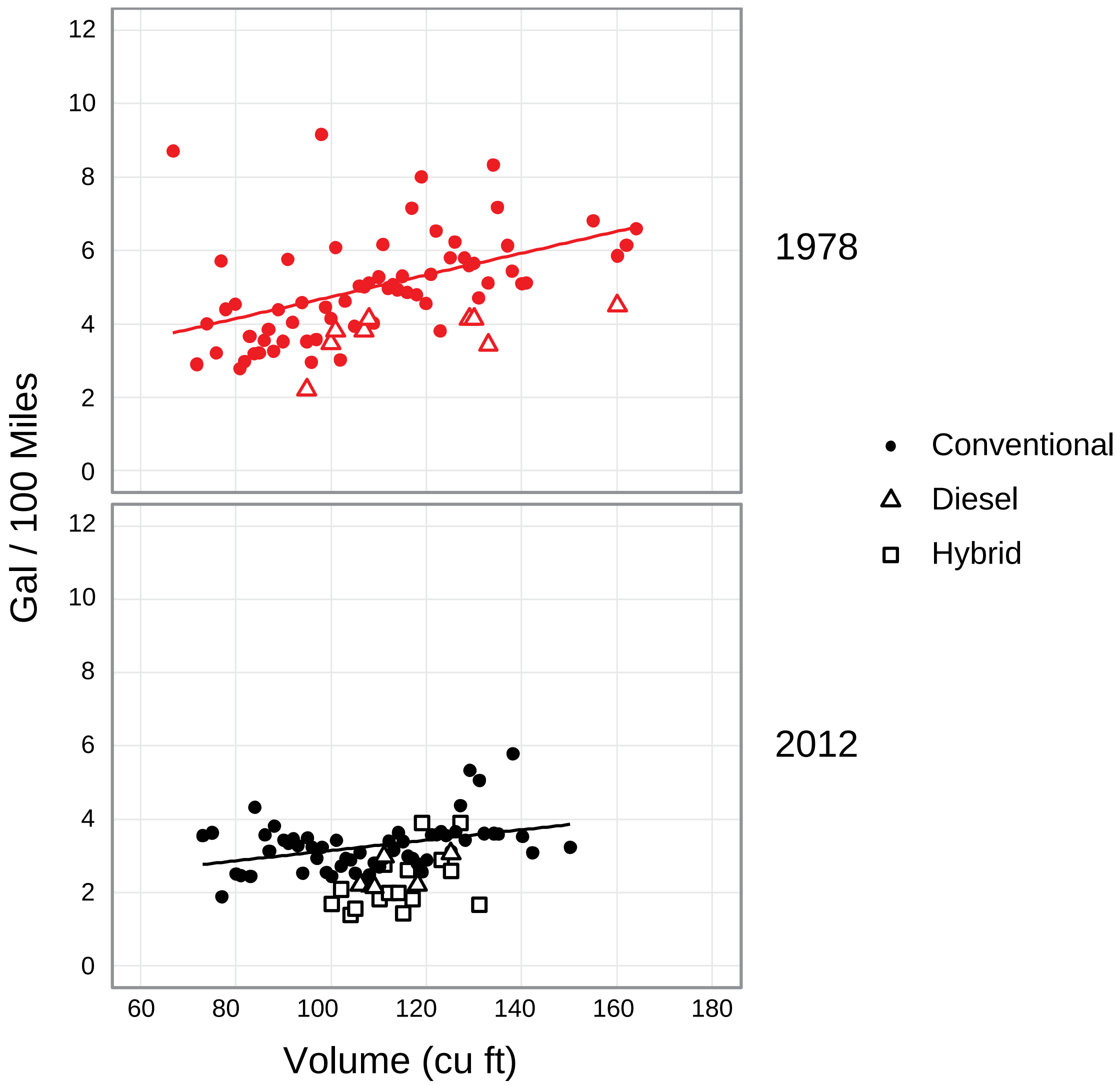


Figure 13 shows laboratory 55/45 fuel consumption versus footprint for MY 2012 cars and trucks, respectively, again with the regression lines excluding the hybrid and diesel data points. Car fuel consumption is more sensitive to footprint than truck fuel consumption. Most cars have footprint values below 50 square feet, and at these footprint levels cars generally have lower fuel consumption than trucks. For the much smaller number of cars that have footprint levels greater than 55 square feet (often high performance cars), these cars generally have higher fuel consumption than trucks of the same footprint.

Figure 13

Laboratory 55/45 Fuel Consumption vs. Footprint, MY 2012 Vehicles

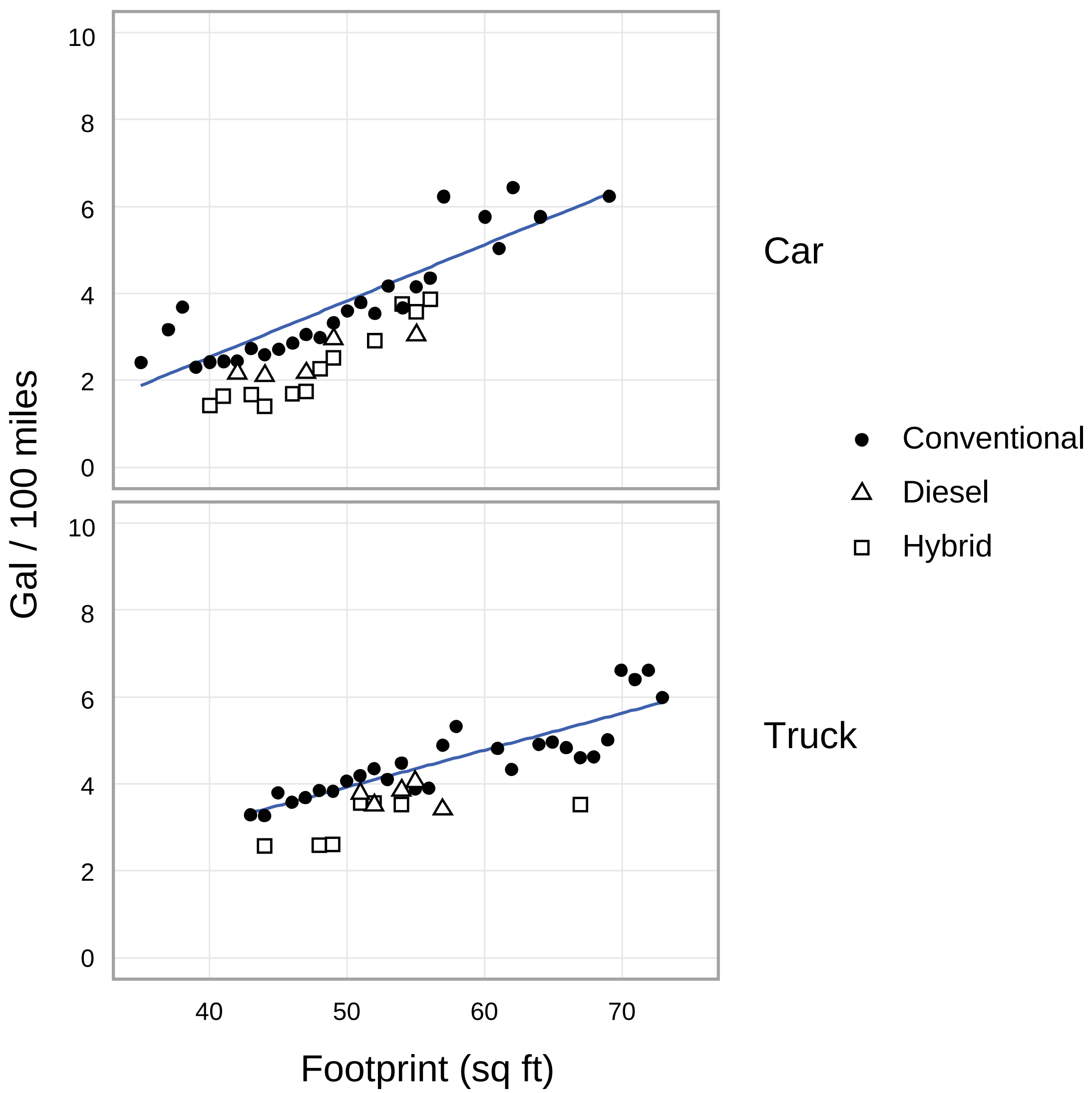


Figure 14 shows the improvement that occurred between MY 1975 and 2012 for fuel consumption as a function of 0-to-60 acceleration time for cars and trucks.

Figure 14

Laboratory 55/45 Fuel Consumption vs. 0-to-60 Time, MY 1975 and MY 2012 Vehicles

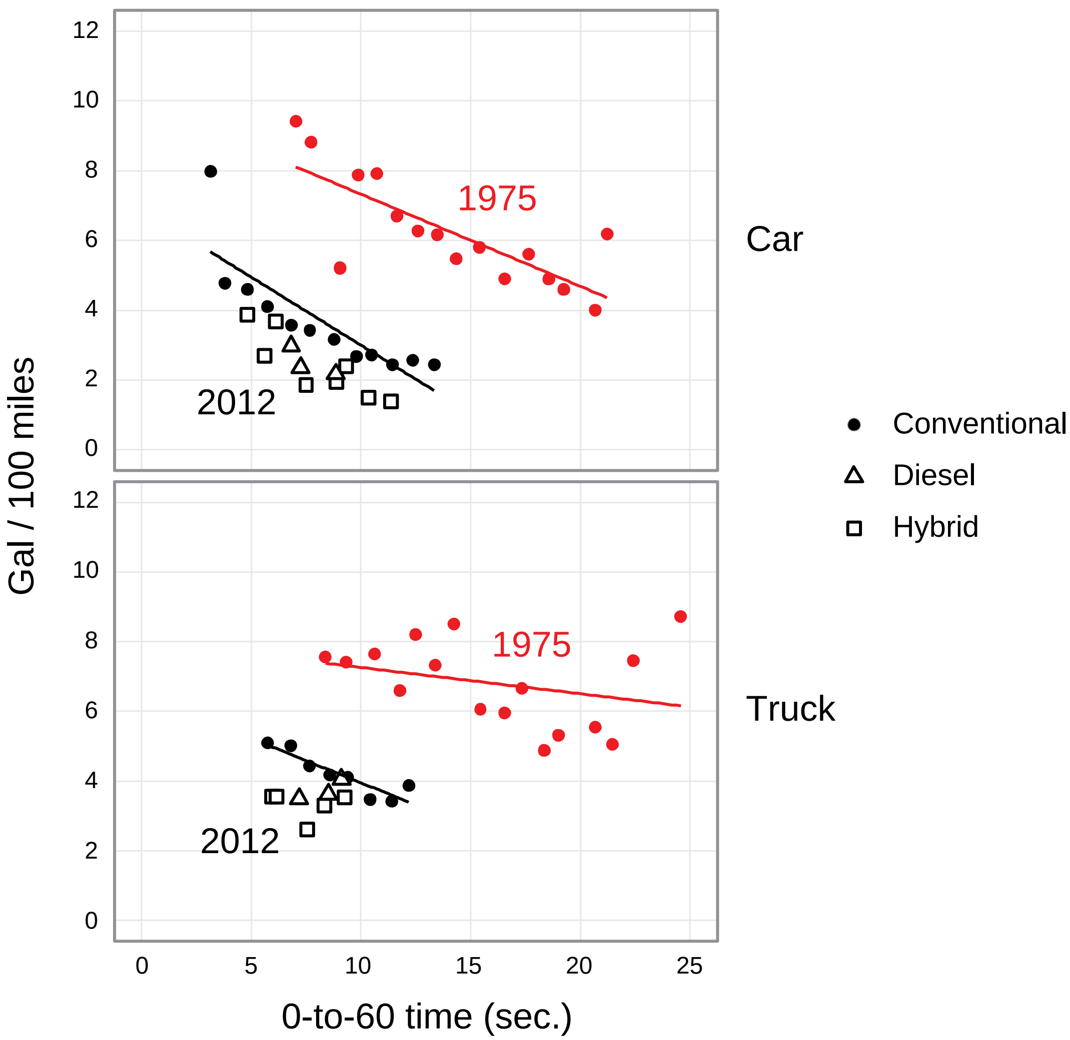


Figure 15 compares Ton-MPG data versus 0-to-60 time and shows that at constant vehicle performance, there has been substantial improvement in Ton-MPG.

Figure 15

Ton-MPG vs. 0-to-60 Time, MY 1975 and MY 2012 Vehicles

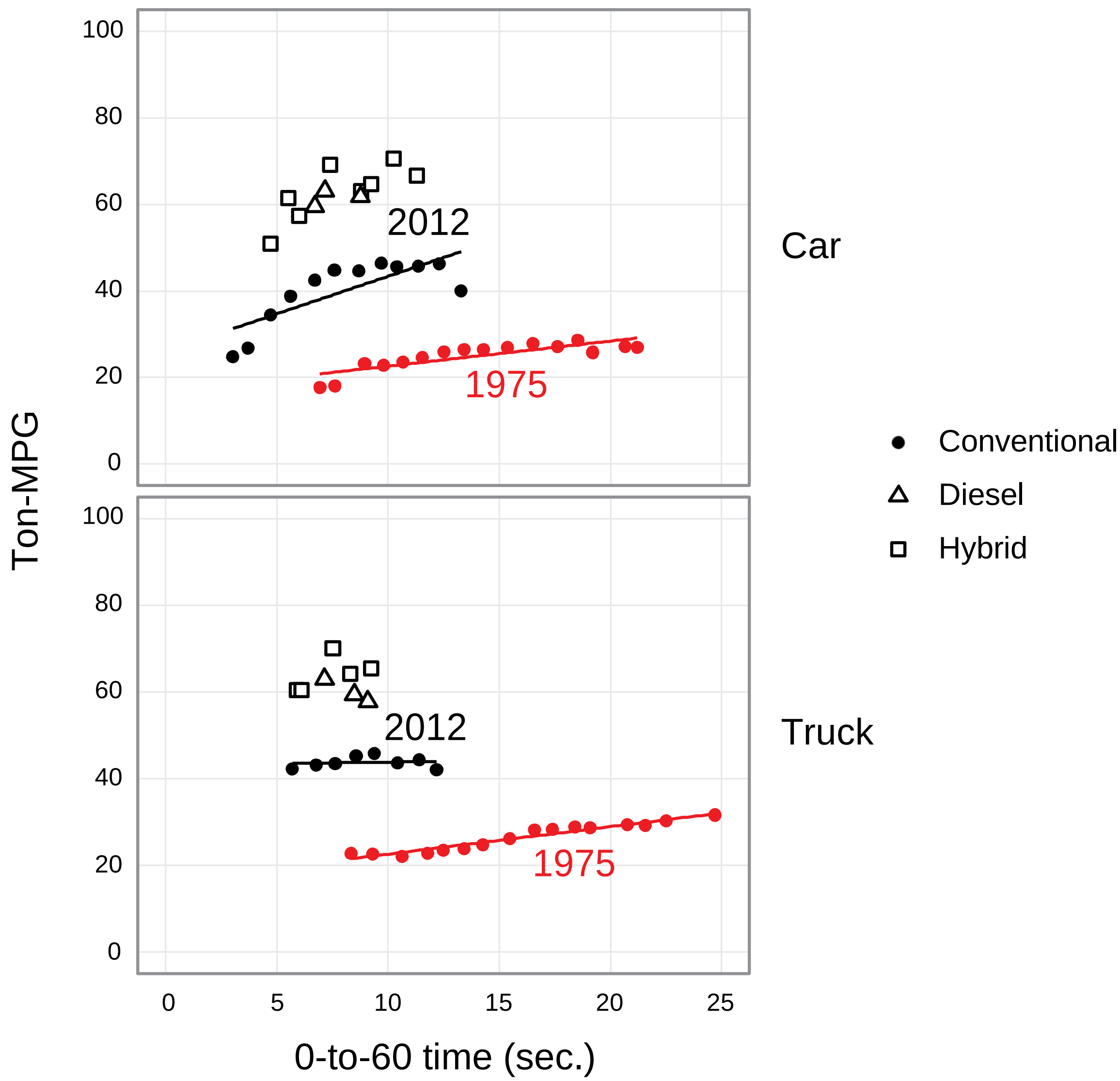


Figure 16 and Table 12 show some of the changes in the distribution of weight that have occurred over the years for the light-duty fleet. In MY 1975, 13% of all light-duty vehicles had weights of less than 3000 lb compared to less than 5% in MY 2012. Since MY 1988, production share for vehicles with weights of 5000 pounds or more has increased from 3% to 18%.

Figure 16

Distribution of Light Vehicle Weight for Three Model Years

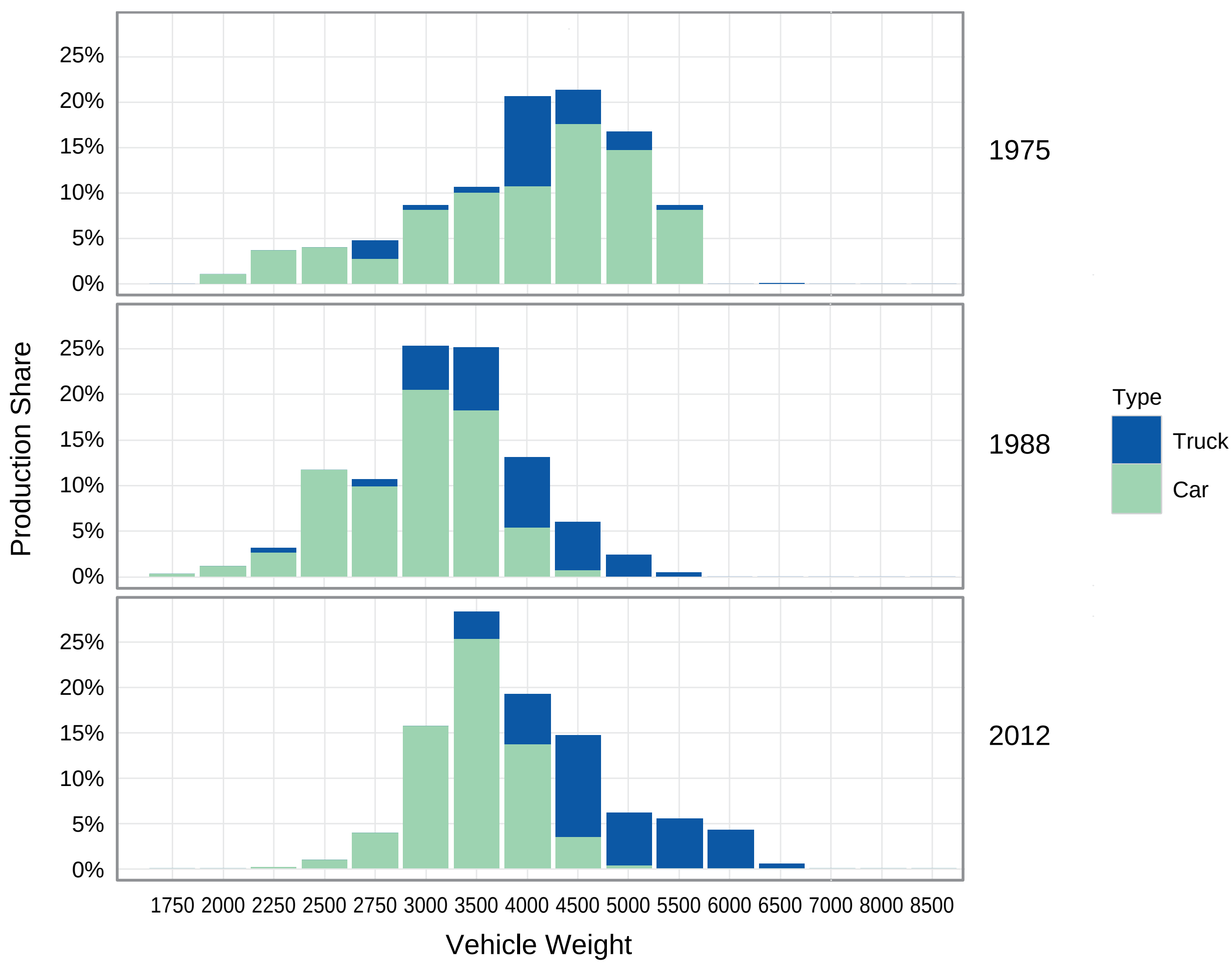


Figure 17 provides data for the annual production share of different weight classes for cars and trucks. In MY 1975, about one-half of the cars were in weight classes greater than 4000 pounds, compared to about 5% this year. For MY 2012, three weight classes (3000, 3500, and 4000 lbs.) account for over 90% of all cars. Conversely, the production share of trucks in the weight classes of 4500 lb. and above have increased substantially, and these vehicles currently account for about 80% of all trucks, compared to about 40% in 1975. Figure 18 provides additional details of the truck data presented in Figure 17 for vans, SUVs, and pickups, respectively. Appendices D, E, and F contain a series of tables describing light-duty vehicles at the vehicle size/type level of stratification in more detail; Appendix G provides similar data by vehicle type and weight class.

Table 12

Light Vehicle Production Share by Weight Class for Three Model Years

Weight (lb)	MY 1975	MY 1988	MY 2012
<3000	13.4%	27.2%	5.0%
3000	8.7%	25.4%	15.8%
3500	10.6%	25.2%	28.5%
4000	20.6%	13.2%	19.4%
4500	21.3%	6.0%	14.8%
5000	16.7%	2.4%	6.2%
5500	8.7%	0.5%	5.5%
>5500	0.0%	0.0%	4.8%
Avg Wt	4060	3283	3950

Figure 17

Production Share by Vehicle Weight Class

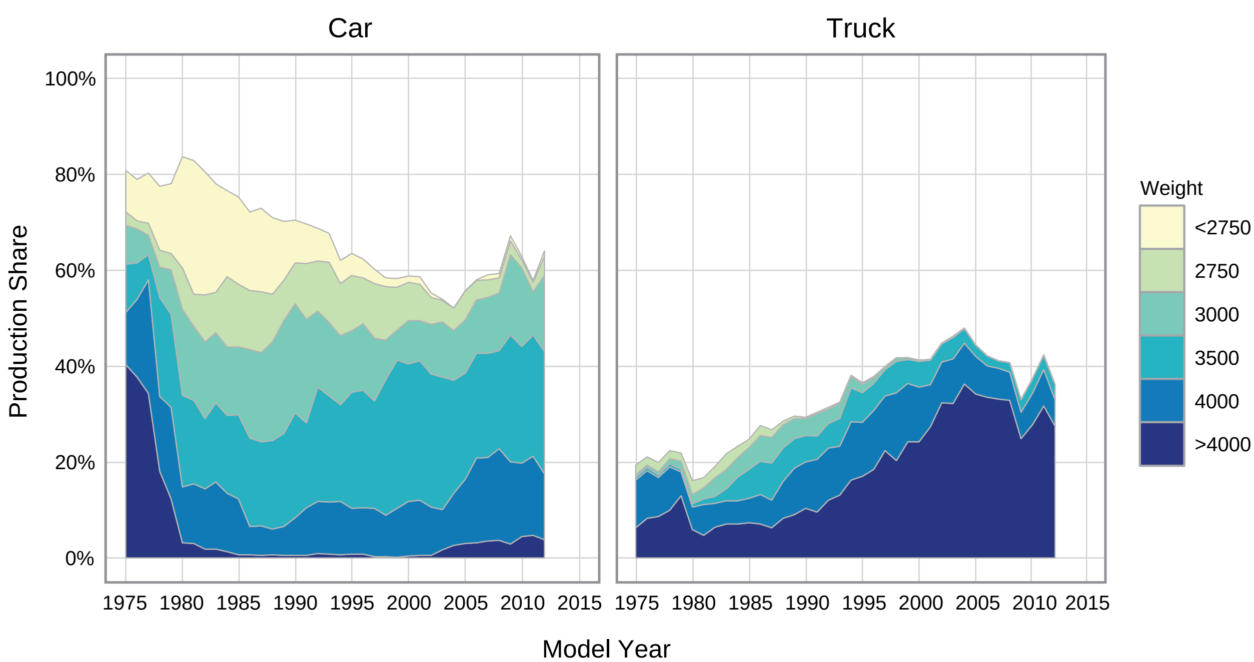
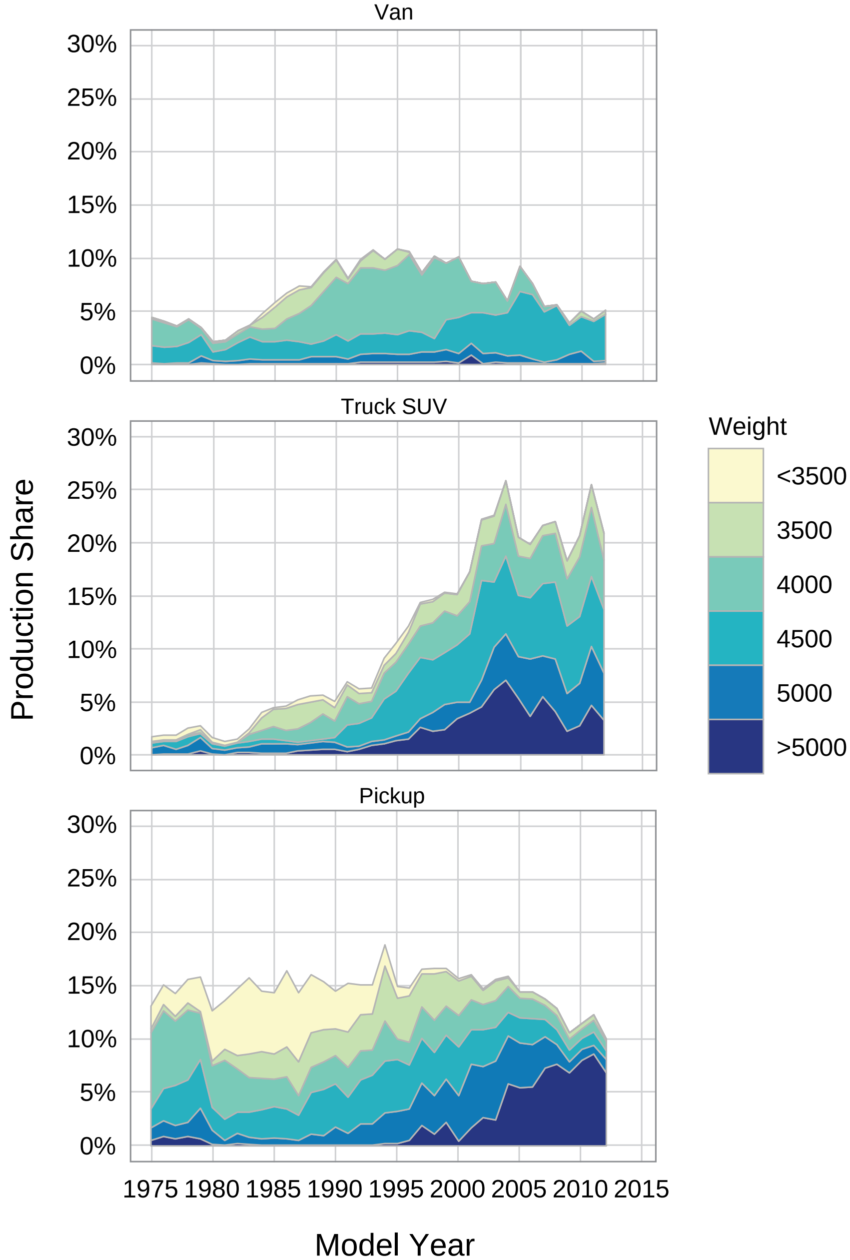


Figure 18

Production Share by Truck Type and Weight Class



VI. Fuel Economy Powertrain Technology Trends

Table 13 presents an overview of key engine technology trends for the MY 1975-2012 database. Conventional gasoline vehicles continue to account for 95% of all light-duty vehicles. While engine size has been relatively stable for over 30 years, overall engine horsepower has consistently increased, with the notable exception of MY 2009. Nearly all engines now have multiple valves (91%) and variable valve timing (projected to exceed 95%). One very important trend is the recent introduction of several new engine technologies. For example, gasoline direct injection engine production share has increased from essentially zero in MY 2007 to 15% in MY 2011, and is projected to be more than 20% in MY 2012. The use of cylinder deactivation has increased to almost 10% of all engines in MY 2011. The use of boost technologies - turbocharging or supercharging - had been in the 2-4% range from MY 1998-2010, but increased to 7% in MY 2011 and are projected to increase to 9% in MY 2012. Appendix K contains additional data on fuel metering and number of valves per cylinder.

Table 14 presents an overview of key transmission and drive technology trends for MY 1975-2012. The data in this table suggest two important trends with respect to transmission design. One, the use of continuously variable transmissions has increased significantly in recent years, growing from nearly zero in 2002 to over 10% of the fleet. The second trend is an increase in the number of transmission gears. The average number of gears has grown from 4 throughout the 1990s to 5.6 in MY 2011, and is projected to be 5.7 in MY 2012. The use of 6-gear transmissions has exploded from less than 5% in 2005 to over 50% in MY 2011 and is projected to exceed 58% in MY 2012. Figure 19 shows the same transmission data in graphical format. More data stratified by transmission type can be found in Appendix I. With respect to drive technologies, the market seems to have approximately stabilized, with about 60% front wheel drive, 15% rear wheel drive, and 25% four wheel drive.

In addition to CVTs, new transmission technologies such as dual clutch transmissions (DCTs) are being introduced into the market. DCTs are essentially automatic transmissions that take advantage of the characteristics of manual transmissions. While characterized as automatic transmissions for this report, DCTs do not have the lock-up torque converter found on nearly all modern automatic transmissions. Currently, automaker submissions to EPA do not explicitly identify DCTs as a separate category. Thus, the introduction of DCTs shows up in Table 14 as a slight increase in automatic transmissions without torque converters (although some DCTs may still be reported as traditional automatic transmissions). EPA intends to further investigate the introduction of DCTs as more explicit data becomes available.

The rest of this section examines the engine, transmission, and drive trends in Tables 13 and 14 in more detail.

Table 15 disaggregates some of the engine and transmission technologies for MY 2012 by vehicle type and size. As discussed earlier, wheelbase is used in this report to distinguish whether a truck is small, mid-size, or large, and four EPA car classes (Two-Seater, Minicompact, Compact, and Subcompact) have been combined to form the small car class. For this table, the car classes are separated into cars, station wagons, and non-truck SUVs, so that the table stratifies light-duty vehicles into a total of 18 vehicle types and sizes. Note that this table does not contain any data for large wagons, small non-truck SUVs, small vans, or small pickups, because none have been produced for several years. Front wheel drive (FWD) is used heavily in all of the car, wagon, non-truck SUV, and van classes, except midsize wagons. Conversely, four wheel drive (4WD) is used heavily in truck SUVs and large pickups. Manual transmissions are used primarily in small vehicles, some sports cars, and midsize pickups. Engines with more than two valves per cylinder and VVT are now prevalent for nearly all vehicle types and sizes.

Detailed tabulations of different technology types, including technology usage percentages for other model years, can be found in the Appendices.

Table 13

Engine Characteristics of MY 1975 to MY 2012 Light Duty Vehicles

Cars

	Powertrain			Fuel Injection Metering Method												
Model Year	Gasoline	Gasoline Hybrid	Diesel	Carbureted	GDI	Port	TBI	Diesel	Avg. Number of Cylinders	CID	HP	HP/ CID	Multi-Valve	VVT	CD	Boosted (Turbocharged or Supercharged)
1975	99.8%	-	0.2%	94.6%	-	5.1%	-	0.2%	6.71	288	136	0.515	-	-	-	-
1976	99.7%	-	0.3%	96.6%	-	3.2%	-	0.3%	6.75	287	134	0.502	-	-	-	-
1977	99.5%	-	0.5%	95.3%	-	4.2%	-	0.5%	6.85	279	133	0.516	-	-	-	-
1978	99.1%	-	0.9%	94.0%	-	5.1%	-	0.9%	6.52	251	124	0.538	-	-	-	-
1979	97.9%	-	2.1%	93.2%	-	4.7%	-	2.1%	6.38	238	119	0.545	-	-	-	-
1980	95.6%	-	4.4%	88.7%	-	6.2%	0.7%	4.4%	5.48	188	100	0.583	-	-	-	-
1981	94.1%	-	5.9%	85.3%	-	6.1%	2.6%	5.9%	5.36	182	99	0.594	-	-	-	-
1982	95.3%	-	4.7%	78.4%	-	7.2%	9.8%	4.7%	5.23	175	99	0.609	-	-	-	-
1983	97.9%	-	2.1%	69.7%	-	9.4%	18.8%	2.1%	5.39	182	104	0.615	-	-	-	-
1984	98.3%	-	1.7%	59.1%	-	14.9%	24.3%	1.7%	5.34	179	106	0.637	-	-	-	-
1985	99.1%	-	0.9%	46.0%	-	21.3%	31.8%	0.9%	5.29	177	111	0.671	-	-	-	-
1986	99.7%	-	0.3%	34.4%	-	36.5%	28.7%	0.3%	5.09	167	111	0.701	4.7%	-	-	-
1987	99.8%	-	0.2%	26.5%	-	42.4%	30.8%	0.2%	4.98	162	113	0.732	14.6%	-	-	-
1988	100.0%	-	0.0%	16.1%	-	53.7%	30.2%	0.0%	5.02	161	116	0.758	19.7%	-	-	-
1989	100.0%	-	0.0%	9.6%	-	62.2%	28.1%	0.0%	5.07	163	121	0.782	24.1%	-	-	-
1990	100.0%	-	0.0%	1.4%	-	77.4%	21.2%	0.0%	5.05	163	129	0.829	32.8%	0.6%	-	-
1991	99.9%	-	0.1%	0.1%	-	77.2%	22.6%	0.1%	5.05	164	133	0.847	33.2%	2.4%	-	-
1992	99.9%	-	0.1%	0.0%	-	88.9%	11.0%	0.1%	5.23	171	141	0.864	34.0%	4.4%	-	-
1993	100.0%	-	-	0.0%	-	91.5%	8.5%	-	5.19	170	140	0.859	34.8%	4.5%	-	-
1994	100.0%	-	0.0%	-	-	94.8%	5.2%	0.0%	5.20	169	144	0.880	39.9%	7.7%	-	-
1995	99.9%	-	0.1%	-	-	98.6%	1.3%	0.1%	5.23	168	153	0.941	51.4%	9.6%	-	-
1996	99.9%	-	0.1%	-	-	98.8%	1.1%	0.1%	5.18	167	155	0.952	56.4%	11.3%	-	0.3%
1997	99.9%	-	0.1%	-	-	99.2%	0.8%	0.1%	5.10	165	156	0.970	58.4%	10.8%	-	0.7%
1998	99.8%	-	0.2%	-	-	99.7%	0.1%	0.2%	5.15	167	160	0.983	59.6%	17.4%	-	2.5%
1999	99.8%	-	0.2%	-	-	99.8%	0.1%	0.2%	5.21	168	164	1.000	63.2%	16.4%	-	3.6%
2000	99.7%	0.1%	0.2%	-	-	99.7%	0.1%	0.2%	5.22	168	168	1.021	63.2%	22.2%	-	2.9%
2001	99.7%	0.0%	0.2%	-	-	99.8%	-	0.2%	5.19	167	169	1.035	65.3%	26.9%	-	3.8%
2002	99.3%	0.3%	0.4%	-	-	99.6%	-	0.4%	5.12	167	173	1.061	69.9%	32.8%	-	4.3%
2003	99.1%	0.6%	0.3%	-	-	99.7%	-	0.3%	5.13	166	176	1.082	73.4%	39.8%	-	2.5%
2004	98.9%	0.9%	0.3%	-	-	99.7%	-	0.3%	5.16	170	184	1.101	77.1%	43.7%	-	4.8%
2005	97.6%	1.9%	0.4%	-	-	99.6%	-	0.4%	5.08	168	183	1.108	77.2%	49.4%	1.0%	3.6%
2006	97.9%	1.5%	0.6%	-	-	99.4%	-	0.6%	5.17	173	194	1.138	81.3%	58.2%	2.0%	4.0%
2007	96.7%	3.2%	0.0%	-	-	99.7%	-	0.0%	5.00	167	191	1.154	84.6%	63.3%	0.9%	4.1%
2008	96.7%	3.3%	0.1%	-	3.1%	96.9%	-	0.1%	4.97	166	194	1.174	88.0%	62.7%	2.0%	4.7%
2009	96.4%	2.9%	0.6%	-	4.2%	95.2%	-	0.6%	4.70	157	186	1.189	92.2%	79.1%	1.8%	4.5%
2010	93.6%	5.5%	0.9%	-	9.2%	89.9%	-	0.9%	4.70	158	190	1.203	93.8%	91.8%	2.1%	4.4%
2011	95.6%	3.4%	0.9%	-	18.4%	80.7%	-	0.9%	4.74	161	200	1.250	94.6%	94.9%	1.3%	8.6%
2012	93.7%	5.3%	1.1%	-	30.4%	68.6%	-	1.1%	4.57	150	192	1.284	97.8%	97.9%	2.0%	10.4%

Table 13 (continued)

Engine Characteristics of MY 1975 to MY 2012 Light Duty Vehicles

Trucks

	Powertrain			Fuel Injection Metering Method												
Model Year	Gasoline	Gasoline Hybrid	Diesel	Carbureted	GDI	Port	TBI	Diesel	Avg. Number of Cylinders	CID	HP	HP/ CID	Multi-Valve	VVT	CD	Boosted (Turbocharged or Supercharged)
1975	100.0%	-	-	99.9%	-	-	0.1%	-	7.28	311	142	0.476	-	-	-	-
1976	100.0%	-	-	99.9%	-	-	0.1%	-	7.31	320	141	0.458	-	-	-	-
1977	100.0%	-	-	99.9%	-	-	0.1%	-	7.28	318	147	0.482	-	-	-	-
1978	99.2%	-	0.8%	99.1%	-	-	0.1%	0.8%	7.25	315	146	0.481	-	-	-	-
1979	98.2%	-	1.8%	97.9%	-	-	0.3%	1.8%	7.05	299	138	0.485	-	-	-	-
1980	96.5%	-	3.5%	94.9%	-	-	1.7%	3.5%	6.15	248	121	0.528	-	-	-	-
1981	94.4%	-	5.6%	93.3%	-	-	1.1%	5.6%	6.15	247	119	0.508	-	-	-	-
1982	90.6%	-	9.4%	89.9%	-	-	0.7%	9.4%	6.26	244	120	0.524	-	-	-	-
1983	95.2%	-	4.8%	94.6%	-	-	0.6%	4.8%	6.07	232	118	0.542	-	-	-	-
1984	97.6%	-	2.4%	95.0%	-	2.0%	0.6%	2.4%	5.99	225	118	0.556	-	-	-	-
1985	98.9%	-	1.1%	86.5%	-	8.9%	3.5%	1.1%	5.97	225	124	0.585	-	-	-	-
1986	99.3%	-	0.7%	59.4%	-	22.1%	17.8%	0.7%	5.71	212	123	0.619	-	-	-	-
1987	99.7%	-	0.3%	33.6%	-	33.3%	32.8%	0.3%	5.69	211	131	0.652	-	-	-	-
1988	99.8%	-	0.2%	12.4%	-	43.2%	44.3%	0.2%	6.00	228	141	0.649	-	-	-	-
1989	99.8%	-	0.2%	6.5%	-	45.9%	47.5%	0.2%	6.04	234	146	0.653	-	-	-	-
1990	99.8%	-	0.2%	3.8%	-	55.0%	40.9%	0.2%	6.17	237	151	0.667	-	-	-	-
1991	99.9%	-	0.1%	1.7%	-	55.3%	42.8%	0.1%	5.95	229	150	0.681	-	-	-	-
1992	99.9%	-	0.1%	1.6%	-	65.7%	32.6%	0.1%	6.09	236	155	0.682	-	-	-	-
1993	100.0%	-	-	1.0%	-	71.5%	27.5%	-	6.13	235	160	0.705	-	-	-	-
1994	100.0%	-	-	0.4%	-	76.2%	23.4%	-	6.19	241	166	0.713	5.2%	-	-	-
1995	100.0%	-	-	-	-	79.4%	20.6%	-	6.22	245	168	0.712	8.0%	-	-	-
1996	99.9%	-	0.1%	-	-	99.9%	-	0.1%	6.25	245	179	0.755	11.2%	-	-	-
1997	100.0%	-	0.0%	-	-	100.0%	-	0.0%	6.47	251	189	0.769	11.1%	-	-	-
1998	100.0%	-	0.0%	-	-	100.0%	-	0.0%	6.30	244	188	0.794	14.8%	-	-	-
1999	100.0%	-	0.0%	-	-	100.0%	-	0.0%	6.50	252	199	0.811	15.7%	-	-	-
2000	100.0%	-	-	-	-	100.0%	-	-	6.48	245	199	0.830	18.6%	4.6%	-	-
2001	100.0%	-	-	-	-	100.0%	-	-	6.58	249	212	0.873	25.9%	9.3%	-	-
2002	100.0%	-	-	-	-	100.0%	-	-	6.57	249	223	0.911	32.8%	16.0%	-	-
2003	100.0%	-	-	-	-	100.0%	-	-	6.56	248	224	0.920	34.6%	19.7%	-	0.5%
2004	100.0%	0.0%	0.0%	-	-	100.0%	-	0.0%	6.70	258	240	0.946	46.2%	32.9%	-	0.9%
2005	99.8%	0.1%	0.1%	-	-	99.9%	-	0.1%	6.58	251	242	0.976	51.1%	41.2%	0.5%	0.7%
2006	98.4%	1.5%	0.1%	-	-	99.9%	-	0.1%	6.50	247	240	0.985	58.4%	51.5%	5.9%	0.8%
2007	99.1%	0.8%	0.1%	-	-	99.9%	-	0.1%	6.57	253	254	1.020	53.3%	48.7%	16.4%	1.1%
2008	98.5%	1.3%	0.2%	-	1.1%	98.7%	-	0.2%	6.42	246	254	1.046	59.5%	51.6%	13.5%	1.3%
2009	98.8%	0.9%	0.3%	-	4.2%	95.5%	-	0.3%	6.23	236	252	1.089	66.6%	56.0%	18.4%	1.8%
2010	98.8%	0.9%	0.4%	-	6.8%	92.9%	-	0.4%	6.22	237	253	1.087	71.5%	70.5%	13.8%	2.0%
2011	99.1%	0.4%	0.5%	-	11.3%	88.1%	-	0.5%	6.18	236	271	1.171	75.2%	90.7%	20.6%	5.2%
2012	98.5%	1.0%	0.5%	-	11.9%	87.6%	-	0.5%	6.17	234	275	1.198	79.3%	94.2%	18.2%	6.2%

Table 13 (continued)

Engine Characteristics of MY 1975 to MY 2012 Light Duty Vehicles

Cars and Trucks

	Powertrain			Fuel Injection Metering Method												
Model Year	Gasoline	Gasoline Hybrid	Diesel	Carbureted	GDI	Port	TBI	Diesel	Avg. Number of Cylinders	CID	HP	HP/ CID	Multi-Valve	VVT	CD	Boosted (Turbocharged or Supercharged)
1975	99.8%	-	0.2%	95.7%	-	4.1%	0.0%	0.2%	6.82	293	137	0.507	-	-	-	-
1976	99.8%	-	0.2%	97.3%	-	2.5%	0.0%	0.2%	6.87	294	135	0.493	-	-	-	-
1977	99.6%	-	0.4%	96.2%	-	3.4%	0.0%	0.4%	6.94	287	136	0.510	-	-	-	-
1978	99.1%	-	0.9%	95.2%	-	3.9%	0.0%	0.9%	6.69	266	129	0.525	-	-	-	-
1979	98.0%	-	2.0%	94.2%	-	3.7%	0.1%	2.0%	6.53	252	124	0.532	-	-	-	-
1980	95.7%	-	4.3%	89.7%	-	5.2%	0.8%	4.3%	5.59	198	104	0.574	-	-	-	-
1981	94.1%	-	5.9%	86.7%	-	5.1%	2.4%	5.9%	5.50	193	102	0.580	-	-	-	-
1982	94.4%	-	5.6%	80.6%	-	5.8%	8.0%	5.6%	5.43	188	103	0.593	-	-	-	-
1983	97.3%	-	2.7%	75.2%	-	7.3%	14.8%	2.7%	5.54	193	107	0.599	-	-	-	-
1984	98.2%	-	1.8%	67.6%	-	11.9%	18.7%	1.8%	5.49	190	109	0.618	-	-	-	-
1985	99.1%	-	0.9%	56.1%	-	18.2%	24.8%	0.9%	5.46	189	114	0.650	-	-	-	-
1986	99.6%	-	0.4%	41.4%	-	32.5%	25.7%	0.4%	5.26	180	114	0.678	3.4%	-	-	-
1987	99.7%	-	0.3%	28.4%	-	39.9%	31.4%	0.3%	5.17	175	118	0.710	10.6%	-	-	-
1988	99.9%	-	0.1%	15.0%	-	50.6%	34.3%	0.1%	5.31	180	123	0.726	14.0%	-	-	-
1989	99.9%	-	0.1%	8.7%	-	57.3%	33.9%	0.1%	5.36	185	129	0.743	16.9%	-	-	-
1990	99.9%	-	0.1%	2.1%	-	70.8%	27.0%	0.1%	5.39	185	135	0.781	23.1%	-	-	-
1991	99.9%	-	0.1%	0.6%	-	70.6%	28.7%	0.1%	5.32	184	138	0.796	23.1%	-	-	-
1992	99.9%	-	0.1%	0.5%	-	81.6%	17.8%	0.1%	5.50	191	145	0.807	23.3%	-	-	-
1993	100.0%	-	-	0.3%	-	85.0%	14.6%	-	5.50	191	147	0.809	23.5%	-	-	-
1994	100.0%	-	0.0%	0.1%	-	87.7%	12.1%	0.0%	5.58	197	152	0.816	26.7%	-	-	-
1995	100.0%	-	0.0%	-	-	91.6%	8.4%	0.0%	5.59	196	158	0.857	35.6%	-	-	-
1996	99.9%	-	0.1%	-	-	99.3%	0.7%	0.1%	5.59	197	164	0.878	39.3%	-	-	0.3%
1997	99.9%	-	0.1%	-	-	99.5%	0.5%	0.1%	5.65	199	169	0.890	39.6%	-	-	0.5%
1998	99.9%	-	0.1%	-	-	99.8%	0.1%	0.1%	5.63	199	171	0.904	40.9%	-	-	2.0%
1999	99.9%	-	0.1%	-	-	99.9%	0.1%	0.1%	5.75	203	179	0.921	43.4%	-	-	2.1%
2000	99.8%	0.0%	0.1%	-	-	99.8%	0.0%	0.1%	5.74	200	181	0.942	44.8%	15.0%	-	1.7%
2001	99.8%	0.0%	0.1%	-	-	99.9%	-	0.1%	5.76	201	187	0.968	49.0%	19.6%	-	2.3%
2002	99.6%	0.2%	0.2%	-	-	99.8%	-	0.2%	5.77	203	195	0.994	53.3%	25.3%	-	2.6%
2003	99.5%	0.3%	0.2%	-	-	99.8%	-	0.2%	5.79	204	199	1.007	55.5%	30.6%	-	1.6%
2004	99.4%	0.5%	0.1%	-	-	99.9%	-	0.1%	5.90	212	211	1.026	62.3%	38.5%	-	2.9%
2005	98.6%	1.1%	0.3%	-	-	99.7%	-	0.3%	5.75	205	209	1.049	65.6%	45.8%	0.8%	2.3%
2006	98.1%	1.5%	0.4%	-	-	99.6%	-	0.4%	5.73	204	213	1.073	71.7%	55.4%	3.6%	2.6%
2007	97.7%	2.2%	0.1%	-	-	99.8%	-	0.1%	5.64	203	217	1.099	71.7%	57.3%	7.3%	2.9%
2008	97.4%	2.5%	0.1%	-	2.3%	97.6%	-	0.1%	5.56	199	219	1.122	76.4%	58.2%	6.7%	3.3%
2009	97.2%	2.3%	0.5%	-	4.2%	95.3%	-	0.5%	5.21	183	208	1.156	83.8%	71.5%	7.3%	3.6%
2010	95.6%	3.8%	0.7%	-	8.3%	91.0%	-	0.7%	5.27	188	214	1.160	85.5%	83.8%	6.4%	3.5%
2011	97.1%	2.2%	0.8%	-	15.4%	83.8%	-	0.8%	5.35	192	230	1.217	86.4%	93.1%	9.5%	7.2%
2012	95.4%	3.7%	0.8%	-	23.7%	75.5%	-	0.8%	5.15	180	222	1.253	91.1%	96.6%	7.9%	8.9%

Table 14

Transmission and Drive Characteristics of MY 1975 to MY 2012 Light Duty Vehicles

Cars

Model Year	Manual	Automatic with Lockup	Automatic without Lockup	CVT	4 Gears or Fewer	5 Gears	6 Gears	7 Gears or More	CVT	Average Number of Gears	Front Wheel Drive	Rear Wheel Drive	Four Wheel Drive
1975	19.7%	0.3%	80.0%	-	98.7%	1.3%	-	-	-	-	6.5%	93.5%	-
1976	17.2%	-	82.8%	-	100.0%	-	-	-	-	-	5.8%	94.2%	-
1977	16.9%	-	83.1%	-	100.0%	-	-	-	-	-	6.8%	93.2%	-
1978	19.9%	7.1%	73.0%	-	90.7%	9.3%	-	-	-	-	9.6%	90.4%	-
1979	21.1%	8.8%	69.6%	-	93.1%	6.9%	-	-	-	3.3	11.9%	87.8%	0.3%
1980	30.9%	16.8%	51.6%	-	87.6%	12.4%	-	-	-	3.5	29.7%	69.4%	0.9%
1981	29.9%	33.3%	36.2%	-	85.5%	14.5%	-	-	-	3.5	37.0%	62.2%	0.7%
1982	29.2%	51.3%	19.1%	-	84.6%	15.4%	-	-	-	3.6	45.6%	53.6%	0.8%
1983	26.0%	56.7%	16.8%	-	80.8%	19.2%	-	-	-	3.7	47.1%	49.9%	3.1%
1984	24.1%	58.3%	17.5%	-	82.1%	17.9%	-	-	-	3.7	53.5%	45.5%	1.0%
1985	22.8%	58.9%	18.4%	-	81.4%	18.6%	-	-	-	3.7	61.1%	36.8%	2.1%
1986	24.7%	58.1%	17.1%	-	79.7%	20.3%	-	-	-	3.8	70.7%	28.2%	1.0%
1987	24.8%	59.7%	15.5%	-	78.4%	21.6%	-	-	-	3.8	76.4%	22.6%	1.1%
1988	24.3%	66.2%	9.5%	-	80.2%	19.8%	-	-	-	3.8	80.9%	18.3%	0.8%
1989	21.1%	69.3%	9.5%	0.1%	81.9%	17.9%	0.0%	-	0.1%	3.9	81.6%	17.4%	1.0%
1990	19.8%	72.8%	7.4%	0.0%	82.4%	17.5%	0.1%	-	0.0%	3.9	84.0%	15.0%	1.0%
1991	20.6%	73.7%	5.7%	0.0%	81.0%	18.9%	0.1%	-	0.0%	3.9	81.1%	17.5%	1.3%
1992	17.6%	76.4%	6.0%	0.0%	83.6%	16.3%	0.1%	-	0.0%	3.9	78.4%	20.5%	1.1%
1993	17.5%	77.6%	4.9%	0.0%	83.2%	16.6%	0.2%	-	0.0%	4.0	80.6%	18.3%	1.1%
1994	16.9%	78.9%	4.1%	-	83.4%	16.3%	0.3%	-	-	4.0	81.3%	18.3%	0.4%
1995	16.3%	81.9%	1.8%	-	83.4%	16.2%	0.4%	-	-	4.1	80.1%	18.8%	1.1%
1996	14.9%	83.6%	1.5%	0.0%	84.9%	14.7%	0.3%	-	0.0%	4.1	83.7%	14.8%	1.4%
1997	13.9%	85.2%	0.8%	0.1%	84.1%	15.5%	0.3%	-	0.1%	4.1	83.8%	14.5%	1.7%
1998	12.2%	87.4%	0.3%	0.1%	82.8%	16.8%	0.3%	-	0.1%	4.1	82.9%	15.0%	2.1%
1999	10.8%	88.6%	0.6%	0.0%	83.4%	16.1%	0.5%	-	0.0%	4.1	83.2%	14.7%	2.1%
2000	10.8%	88.1%	1.0%	0.0%	81.3%	17.9%	0.8%	-	0.0%	4.1	80.4%	17.7%	2.0%
2001	11.0%	88.0%	0.8%	0.2%	78.5%	20.2%	1.2%	-	0.2%	4.2	80.3%	16.7%	3.0%
2002	10.9%	88.4%	0.2%	0.4%	77.4%	20.3%	1.9%	-	0.4%	4.2	82.9%	13.5%	3.6%
2003	10.9%	87.7%	-	1.4%	67.5%	27.9%	3.1%	-	1.4%	4.3	80.9%	15.9%	3.2%
2004	9.8%	88.2%	0.2%	1.7%	64.5%	28.4%	5.0%	0.4%	1.7%	4.4	80.2%	14.5%	5.3%
2005	8.8%	88.4%	0.1%	2.8%	57.3%	33.7%	5.8%	0.4%	2.8%	4.5	79.2%	14.2%	6.6%
2006	8.8%	88.4%	0.1%	2.7%	47.5%	35.4%	12.5%	1.9%	2.7%	4.7	75.9%	18.0%	6.0%
2007	7.8%	82.5%	0.0%	9.7%	36.8%	34.7%	16.5%	2.3%	9.7%	4.8	81.0%	13.4%	5.6%
2008	7.2%	81.7%	0.3%	10.8%	39.3%	28.2%	19.0%	2.6%	10.8%	4.8	78.8%	14.1%	7.1%
2009	6.2%	82.4%	0.3%	11.1%	35.1%	31.4%	19.3%	3.1%	11.1%	4.9	83.5%	10.2%	6.3%
2010	5.0%	79.5%	1.6%	13.9%	29.5%	20.2%	33.0%	3.4%	13.9%	5.1	82.5%	11.2%	6.3%
2011	4.6%	83.0%	0.5%	11.9%	15.8%	12.9%	53.8%	5.5%	11.9%	5.6	80.1%	11.3%	8.6%
2012	7.6%	75.4%	5.1%	11.9%	7.2%	13.8%	60.9%	6.2%	11.9%	5.8	83.1%	10.2%	6.7%

Table 14 (continued)

Transmission and Drive Characteristics of MY 1975 to MY 2012 Light Duty Vehicles

Trucks

Model Year	Manual	Automatic with Lockup	Automatic without Lockup	CVT	4 Gears or Fewer	5 Gears	6 Gears	7 Gears or More	CVT	Average Number of Gears	Front Wheel Drive	Rear Wheel Drive	Four Wheel Drive
1975	36.9%	-	63.1%	-	100.0%	-	-	-	-	-	-	82.8%	17.2%
1976	34.7%	-	65.3%	-	100.0%	-	-	-	-	-	-	77.0%	23.0%
1977	31.6%	-	68.4%	-	100.0%	-	-	-	-	-	-	76.2%	23.8%
1978	32.1%	-	67.9%	-	99.3%	0.7%	-	-	-	-	-	70.9%	29.1%
1979	35.1%	2.1%	62.8%	-	96.0%	4.0%	-	-	-	3.3	-	81.9%	18.1%
1980	53.0%	24.5%	22.4%	-	89.2%	10.8%	-	-	-	3.5	1.4%	73.6%	25.0%
1981	51.6%	31.1%	17.3%	-	86.1%	13.9%	-	-	-	3.6	1.9%	78.0%	20.1%
1982	45.9%	33.4%	20.7%	-	83.8%	16.2%	-	-	-	3.7	1.7%	78.1%	20.2%
1983	46.3%	36.0%	17.4%	-	81.6%	18.4%	-	-	-	3.9	1.4%	72.5%	26.1%
1984	42.5%	34.6%	22.9%	-	78.6%	21.4%	-	-	-	3.9	5.0%	63.5%	31.5%
1985	37.6%	41.1%	21.2%	-	78.6%	21.4%	-	-	-	3.8	7.3%	61.4%	31.3%
1986	43.0%	41.5%	15.5%	-	69.1%	30.9%	-	-	-	4.0	5.9%	63.4%	30.7%
1987	40.5%	43.8%	15.7%	-	70.1%	29.9%	-	-	-	4.0	7.6%	60.2%	32.2%
1988	35.8%	52.5%	11.7%	-	68.4%	31.6%	-	-	-	4.1	9.2%	56.7%	34.1%
1989	32.8%	56.4%	10.8%	-	70.3%	29.7%	-	-	-	4.1	10.1%	57.1%	32.8%
1990	28.1%	67.5%	4.4%	-	74.1%	25.9%	-	-	-	4.1	15.8%	52.4%	31.8%
1991	31.5%	66.8%	1.7%	-	69.0%	31.0%	-	-	-	4.2	10.3%	52.3%	37.3%
1992	27.5%	71.3%	1.2%	-	74.6%	25.4%	-	-	-	4.2	14.5%	52.1%	33.4%
1993	24.7%	74.2%	1.1%	-	76.0%	24.0%	-	-	-	4.2	16.8%	50.6%	32.7%
1994	23.7%	75.3%	1.0%	-	76.7%	23.3%	-	-	-	4.2	13.8%	47.0%	39.2%
1995	20.7%	78.5%	0.9%	-	79.6%	20.4%	-	-	-	4.2	18.4%	39.3%	42.3%
1996	15.6%	83.4%	1.0%	-	84.4%	15.6%	-	-	-	4.1	20.9%	39.8%	39.2%
1997	14.1%	85.8%	0.1%	-	79.9%	20.1%	-	-	-	4.2	14.2%	40.6%	45.2%
1998	13.6%	85.8%	0.6%	-	81.1%	18.9%	-	-	-	4.2	19.3%	35.5%	45.1%
1999	9.2%	90.4%	0.4%	-	85.8%	14.2%	-	-	-	4.1	17.5%	34.4%	48.1%
2000	8.2%	91.5%	0.3%	-	87.3%	12.7%	-	-	-	4.1	20.0%	33.8%	46.3%
2001	6.3%	93.4%	0.3%	-	84.0%	16.0%	-	-	-	4.2	16.3%	34.8%	48.8%
2002	4.7%	94.9%	0.3%	0.0%	76.7%	23.3%	-	-	0.0%	4.2	15.4%	33.1%	51.6%
2003	4.6%	94.4%	0.3%	0.6%	71.1%	28.2%	-	-	0.6%	4.3	15.4%	34.1%	50.4%
2004	3.5%	95.6%	0.3%	0.6%	63.2%	35.5%	0.8%	-	0.6%	4.4	12.5%	31.0%	56.5%
2005	2.9%	95.3%	-	1.8%	54.3%	41.9%	2.1%	-	1.8%	4.5	20.1%	27.7%	52.2%
2006	3.3%	93.7%	-	3.1%	48.0%	44.3%	3.8%	0.8%	3.1%	4.6	18.9%	28.0%	53.1%
2007	2.6%	93.8%	-	3.7%	45.8%	38.0%	11.5%	1.0%	3.7%	4.7	16.1%	28.4%	55.5%
2008	2.2%	94.1%	-	3.6%	37.9%	37.4%	19.9%	1.2%	3.6%	4.8	18.4%	24.8%	56.8%
2009	2.0%	92.0%	-	6.0%	23.5%	33.7%	35.1%	1.6%	6.0%	5.2	21.0%	20.5%	58.4%
2010	1.8%	91.9%	0.4%	5.9%	16.4%	29.1%	46.7%	1.9%	5.9%	5.4	20.9%	18.0%	61.0%
2011	1.3%	91.4%	0.0%	7.3%	11.9%	26.5%	50.5%	3.9%	7.3%	5.5	17.7%	17.3%	65.0%
2012	1.9%	90.3%	-	7.8%	11.9%	22.4%	54.3%	3.6%	7.8%	5.6	22.1%	18.3%	59.6%

Table 14 (continued)

Transmission and Drive Characteristics of MY 1975 to MY 2012 Light Duty Vehicles

Cars and Trucks

Model Year	Manual	Automatic with Lockup	Automatic without Lockup	CVT	4 Gears or Fewer	5 Gears	6 Gears	7 Gears or More	CVT	Average Number of Gears	Front Wheel Drive	Rear Wheel Drive	Four Wheel Drive
1975	23.0%	0.2%	76.8%	-	99.0%	1.0%	-	-	-	-	5.3%	91.4%	3.3%
1976	20.9%	-	79.1%	-	100.0%	-	-	-	-	-	4.6%	90.6%	4.8%
1977	19.8%	-	80.2%	-	100.0%	-	-	-	-	-	5.5%	89.8%	4.7%
1978	22.7%	5.5%	71.9%	-	92.7%	7.3%	-	-	-	-	7.4%	86.0%	6.6%
1979	24.2%	7.3%	68.1%	-	93.8%	6.2%	-	-	-	3.3	9.2%	86.5%	4.3%
1980	34.6%	18.1%	46.8%	-	87.9%	12.1%	-	-	-	3.5	25.0%	70.1%	4.9%
1981	33.6%	33.0%	32.9%	-	85.6%	14.4%	-	-	-	3.5	31.0%	65.0%	4.0%
1982	32.4%	47.8%	19.4%	-	84.4%	15.6%	-	-	-	3.6	37.0%	58.4%	4.6%
1983	30.5%	52.1%	17.0%	-	80.9%	19.1%	-	-	-	3.7	37.0%	54.8%	8.1%
1984	28.4%	52.8%	18.8%	-	81.3%	18.7%	-	-	-	3.7	42.1%	49.8%	8.2%
1985	26.5%	54.5%	19.1%	-	80.7%	19.3%	-	-	-	3.8	47.8%	42.9%	9.3%
1986	29.8%	53.5%	16.7%	-	76.8%	23.2%	-	-	-	3.8	52.6%	38.0%	9.3%
1987	29.1%	55.4%	15.5%	-	76.2%	23.8%	-	-	-	3.9	57.7%	32.8%	9.6%
1988	27.6%	62.2%	10.2%	-	76.8%	23.2%	-	-	-	3.9	60.0%	29.5%	10.5%
1989	24.6%	65.5%	9.9%	0.1%	78.5%	21.4%	0.0%	-	0.1%	3.9	60.2%	29.3%	10.5%
1990	22.2%	71.2%	6.5%	0.0%	79.9%	20.0%	0.1%	-	0.0%	4.0	63.8%	26.1%	10.1%
1991	23.9%	71.6%	4.5%	0.0%	77.3%	22.6%	0.0%	-	0.0%	4.0	59.6%	28.1%	12.3%
1992	20.7%	74.8%	4.5%	0.0%	80.8%	19.2%	0.1%	-	0.0%	4.0	58.4%	30.4%	11.2%
1993	19.8%	76.5%	3.7%	0.0%	80.9%	19.0%	0.1%	-	0.0%	4.0	59.9%	28.8%	11.3%
1994	19.5%	77.6%	3.0%	-	80.8%	19.0%	0.2%	-	-	4.1	55.6%	29.2%	15.2%
1995	17.9%	80.7%	1.4%	-	82.0%	17.7%	0.2%	-	-	4.1	57.6%	26.3%	16.2%
1996	15.2%	83.5%	1.3%	0.0%	84.7%	15.1%	0.2%	-	0.0%	4.1	60.0%	24.3%	15.7%
1997	14.0%	85.5%	0.5%	0.0%	82.4%	17.3%	0.2%	-	0.0%	4.1	56.1%	24.9%	19.0%
1998	12.8%	86.7%	0.5%	0.0%	82.1%	17.7%	0.2%	-	0.0%	4.1	56.4%	23.5%	20.1%
1999	10.1%	89.4%	0.5%	0.0%	84.4%	15.3%	0.3%	-	0.0%	4.1	55.8%	22.9%	21.3%
2000	9.7%	89.5%	0.7%	0.0%	83.7%	15.8%	0.5%	-	0.0%	4.1	55.5%	24.3%	20.2%
2001	9.0%	90.3%	0.6%	0.1%	80.7%	18.5%	0.7%	-	0.1%	4.2	53.8%	24.2%	22.0%
2002	8.2%	91.4%	0.3%	0.2%	77.1%	21.6%	1.1%	-	0.2%	4.2	52.7%	22.3%	25.0%
2003	8.0%	90.8%	0.1%	1.1%	69.2%	28.1%	1.7%	-	1.1%	4.3	50.7%	24.3%	25.0%
2004	6.8%	91.8%	0.3%	1.2%	63.9%	31.8%	3.0%	0.2%	1.2%	4.4	47.7%	22.4%	29.8%
2005	6.2%	91.5%	0.1%	2.3%	56.0%	37.3%	4.1%	0.2%	2.3%	4.5	53.0%	20.2%	26.8%
2006	6.5%	90.6%	0.0%	2.8%	47.7%	39.2%	8.8%	1.4%	2.8%	4.6	51.9%	22.3%	25.8%
2007	5.6%	87.1%	0.0%	7.2%	40.5%	36.1%	14.4%	1.8%	7.2%	4.8	54.3%	19.6%	26.1%
2008	5.2%	86.8%	0.2%	7.9%	38.8%	31.9%	19.4%	2.0%	7.9%	4.8	54.2%	18.5%	27.3%
2009	4.8%	85.5%	0.2%	9.4%	31.3%	32.2%	24.5%	2.6%	9.4%	5.0	62.9%	13.6%	23.5%
2010	3.8%	84.1%	1.2%	10.9%	24.6%	23.5%	38.1%	2.8%	10.9%	5.2	59.5%	13.8%	26.7%
2011	3.2%	86.6%	0.3%	10.0%	14.2%	18.7%	52.4%	4.8%	10.0%	5.6	53.8%	13.8%	32.4%
2012	5.6%	80.8%	3.2%	10.4%	8.9%	16.9%	58.5%	5.3%	10.4%	5.7	61.1%	13.1%	25.8%

Figure 19

Transmission Production Share by Model Year

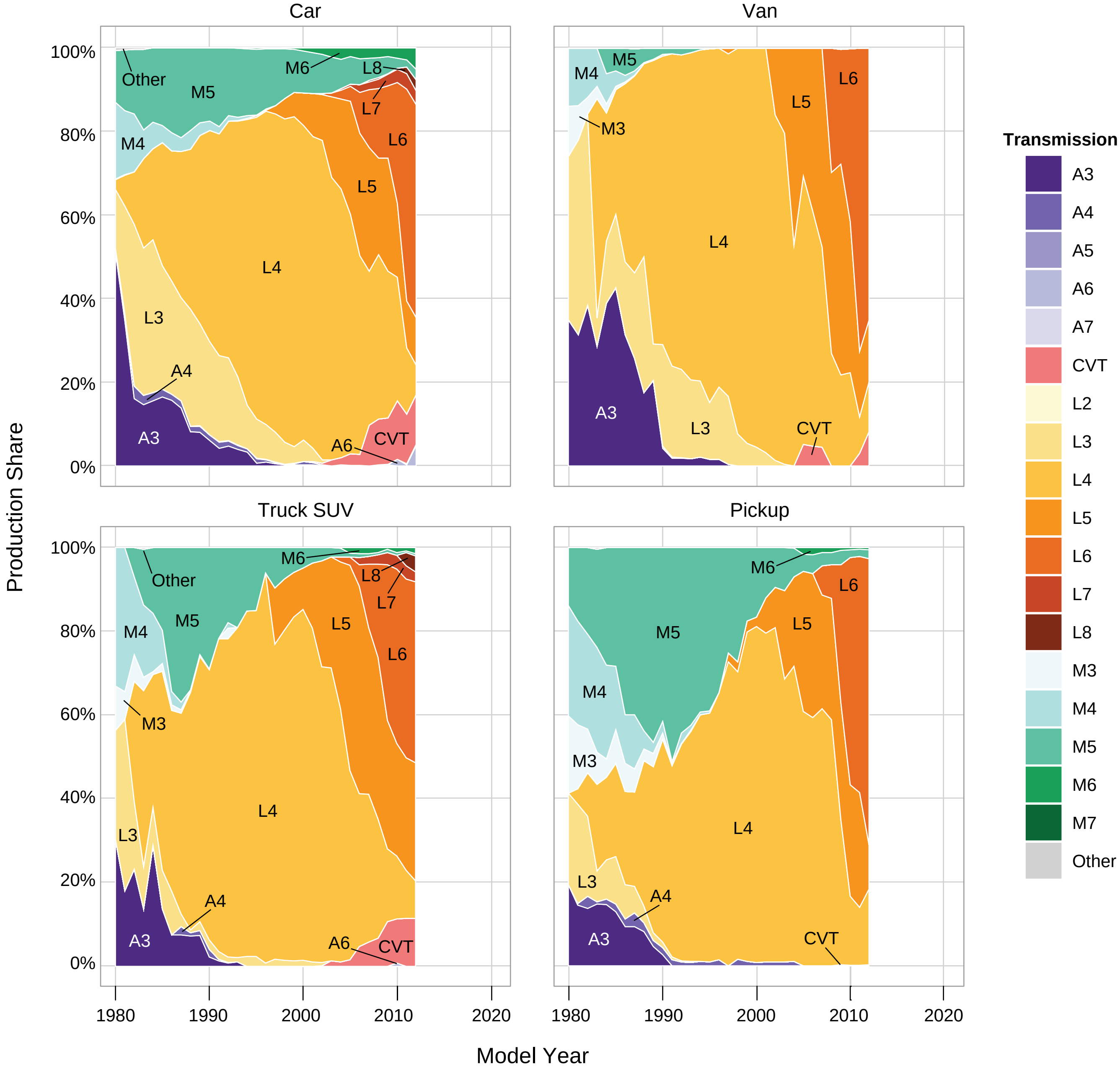


Table 15

MY 2012 Technology Usage by Vehicle Type and Size (Percent of Vehicle Type/Size Strata)

Vehicle Type	Vehicle Size	Front Wheel Drive	Four Wheel Drive	Manual Trans	Multi-Valve	VVT
Car	Small	80%	4%	14%	96%	97%
Car	Midsize	87%	7%	4%	99%	99%
Car	Large	75%	5%	1%	94%	99%
Car	All	83%	5%	8%	97%	98%
Wagon	Small	82%	16%	13%	100%	93%
Wagon	Midsize	97%	3%	-	100%	100%
Wagon	All	83%	15%	12%	100%	94%
Non-Truck SUV	Midsize	97%	-	1%	100%	100%
Non-Truck SUV	Large	72%	27%	-	100%	100%
Non-Truck SUV	All	87%	11%	1%	100%	100%
Van	Midsize	97%	3%	-	99%	92%
Van	Large	-	10%	-	-	31%
Van	All	93%	3%	-	95%	89%
Truck SUV	Midsize	11%	87%	3%	94%	94%
Truck SUV	Large	20%	67%	1%	80%	99%
Truck SUV	All	15%	76%	2%	87%	96%
Pickup	Midsize	-	28%	36%	100%	100%
Pickup	Large	-	54%	2%	54%	92%
Pickup	All	-	53%	3%	55%	92%

Figure 20 shows trends in drive use for the six vehicle classes. Cars and wagons used to be nearly all rear wheel drive, but are now nearly all front wheel drive and four wheel drive. The trend towards increased use of front wheel drive for vans is very similar to that for cars, except it started a few years later. Almost all non-truck SUVs are front wheel drive vehicles, while almost all truck SUVs are four wheel drive vehicles. Consistent with load-carrying capabilities, all pickup trucks use either rear or four wheel drive, and four wheel drive is over 50% of pickup production.

Figure 20

Front, Rear, and Four Wheel Drive Usage - Production Share by Vehicle Type

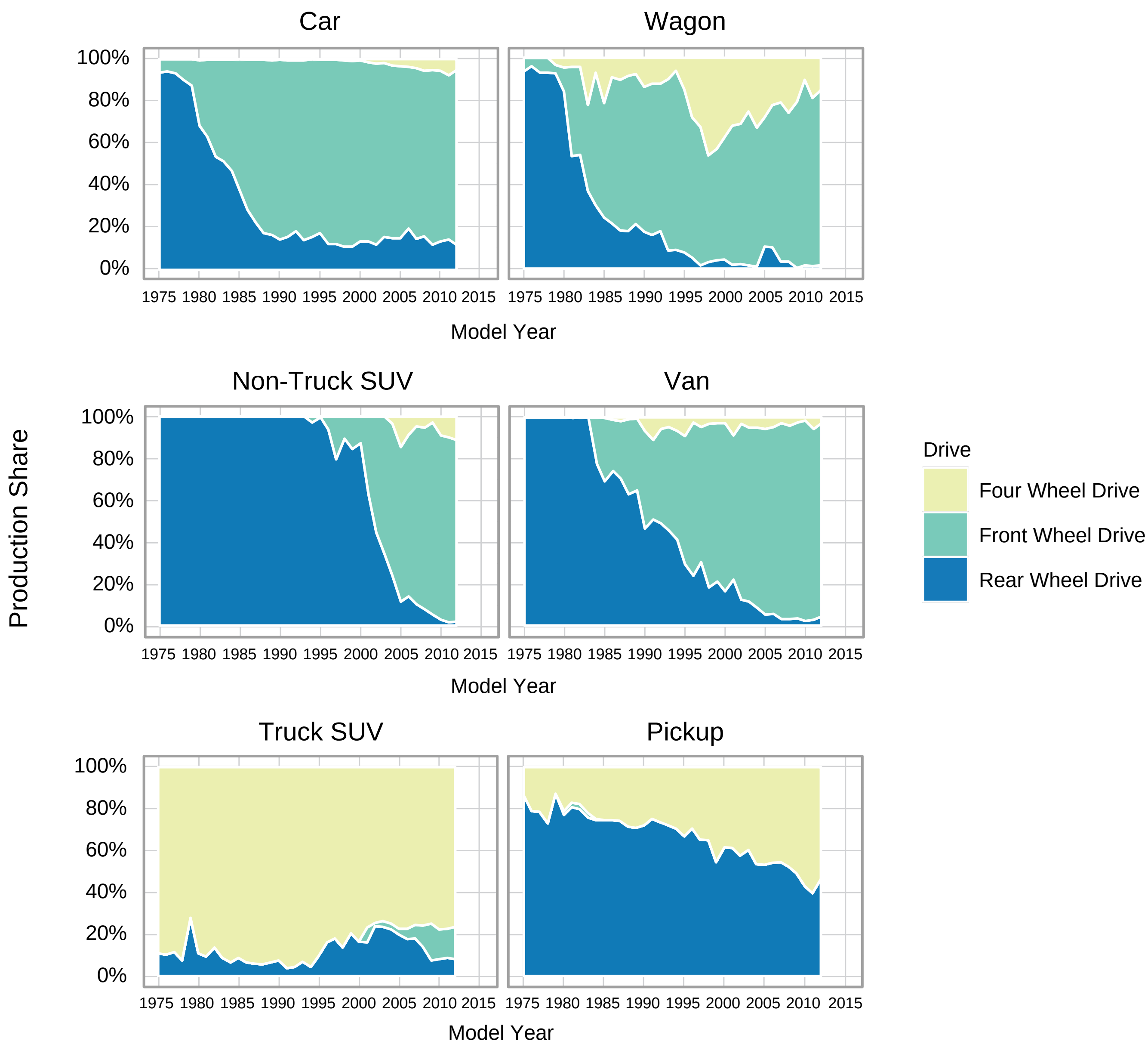


Figure 21 and Table 16 show production share stratified by number of engine cylinders. Engines with 8, 6, and 4 cylinders have accounted for 97 to 99% of all engines produced since MY 1975. The 8-cylinder engine was dominant in the mid and late 1970s, accounting for over half of production. Subsequently, while production share stratified by number of engine cylinders varied over time, there were two years with notable production shifts. The first major shift was in MY 1980, when 8-cylinder engine production share dropped from 54% to 26%, and 4-cylinder production share increased from 26% to 45%. The 4-cylinder engine continued to lead the market until overtaken by 6-cylinder engines in MY 1992. The second major shift was in MY 2009, when 4-cylinder engines once again became the production leader with 51% (an increase of 13% in a single year), followed by 6-cylinder engines with 35%, and 8-cyinder engines at an all-time low of 12%. This shift in MY 2009 reversed very slightly in MY 2010-2011, but is projected to reverse again in MY 2012. Figure 22 breaks out the data for engine cylinders by vehicle type. It can be seen that 4-cylinder engines account for 70% of cars and about 25% of truck SUVs, but are used only rarely in pickups and vans. Vans are almost exclusively powered by 6-cylinder engines, and pickups use mostly 8-cylinder engines. Over one-half of all truck SUVs use 6-cylinder engines.

Figure 21

Production Share by Number of Cylinders

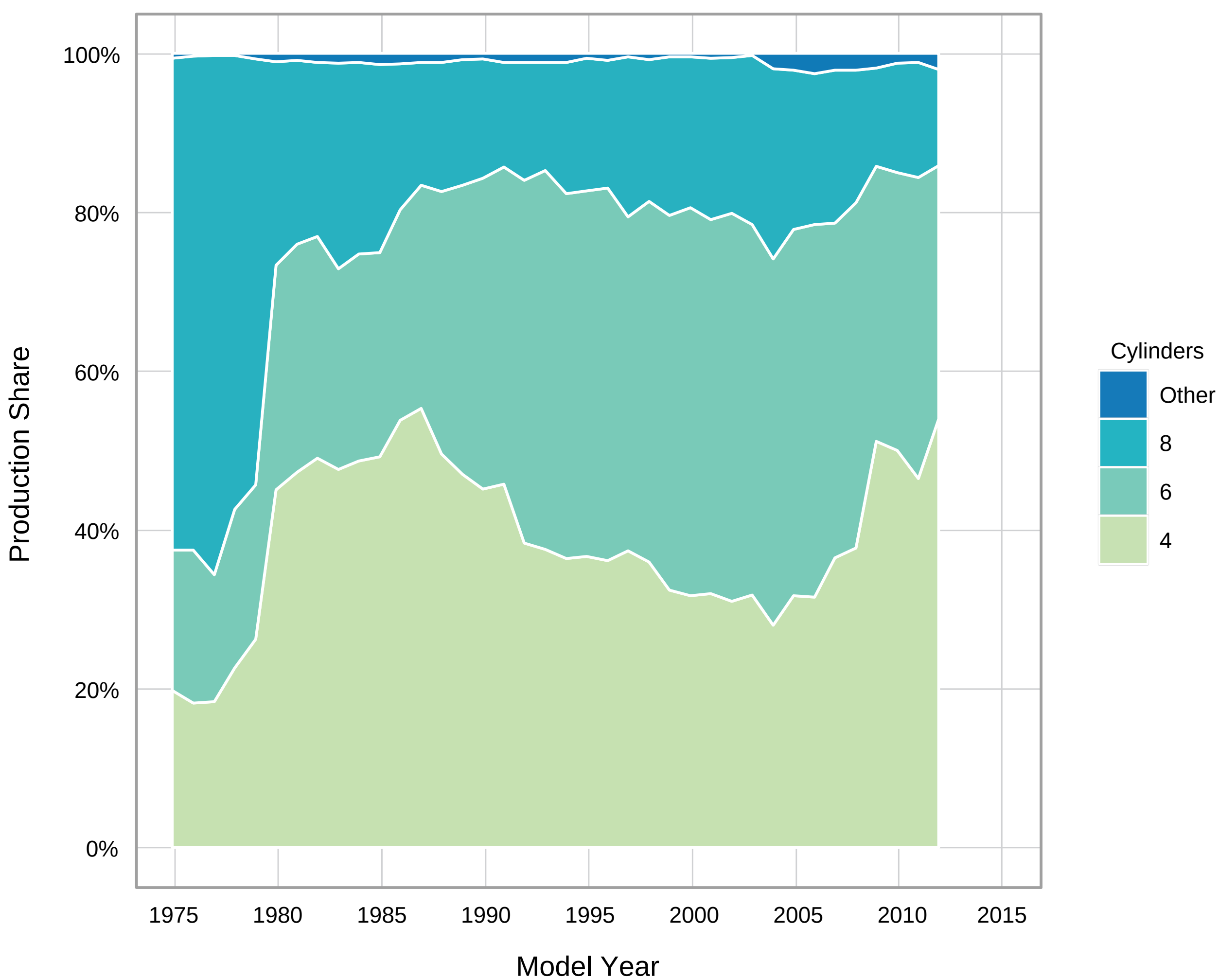


Table 16

Production Share by Number of Cylinders

Model Year	4 Cylinder	6 Cylinder	8 Cylinder	Other
1975	19.8%	17.7%	61.9%	0.6%
1976	18.2%	19.3%	62.2%	0.4%
1977	18.4%	16.0%	65.4%	0.2%
1978	22.6%	20.0%	57.1%	0.3%
1979	26.2%	19.5%	53.6%	0.7%
1980	45.1%	28.3%	25.6%	1.1%
1981	47.3%	28.7%	23.1%	0.9%
1982	49.0%	28.0%	21.9%	1.1%
1983	47.6%	25.3%	25.9%	1.2%
1984	48.7%	26.1%	24.1%	1.1%
1985	49.2%	25.7%	23.7%	1.4%
1986	53.8%	26.5%	18.4%	1.4%
1987	55.3%	28.1%	15.4%	1.2%
1988	49.6%	33.0%	16.3%	1.1%
1989	47.0%	36.4%	15.8%	0.8%
1990	45.1%	39.2%	15.0%	0.7%
1991	45.7%	39.9%	13.2%	1.1%
1992	38.4%	45.6%	14.8%	1.2%
1993	37.6%	47.7%	13.6%	1.2%
1994	36.4%	46.0%	16.5%	1.2%
1995	36.7%	46.0%	16.7%	0.6%
1996	36.2%	46.9%	16.1%	0.9%
1997	37.4%	42.1%	20.1%	0.5%
1998	35.9%	45.4%	17.9%	0.8%
1999	32.4%	47.2%	19.9%	0.4%
2000	31.7%	48.9%	19.0%	0.5%
2001	32.0%	47.1%	20.4%	0.6%
2002	31.0%	48.8%	19.6%	0.5%
2003	31.8%	46.6%	21.3%	0.3%
2004	28.0%	46.1%	23.9%	2.0%
2005	31.7%	46.2%	20.0%	2.1%
2006	31.5%	47.0%	18.9%	2.6%
2007	36.5%	42.1%	19.3%	2.1%
2008	37.7%	43.4%	16.8%	2.1%
2009	51.1%	34.7%	12.3%	1.8%
2010	50.0%	35.0%	13.8%	1.2%
2011	46.5%	37.8%	14.5%	1.2%
2012	54.0%	31.9%	12.1%	2.0%

Figure 22

Production Share by Cylinder Count and Vehicle Type

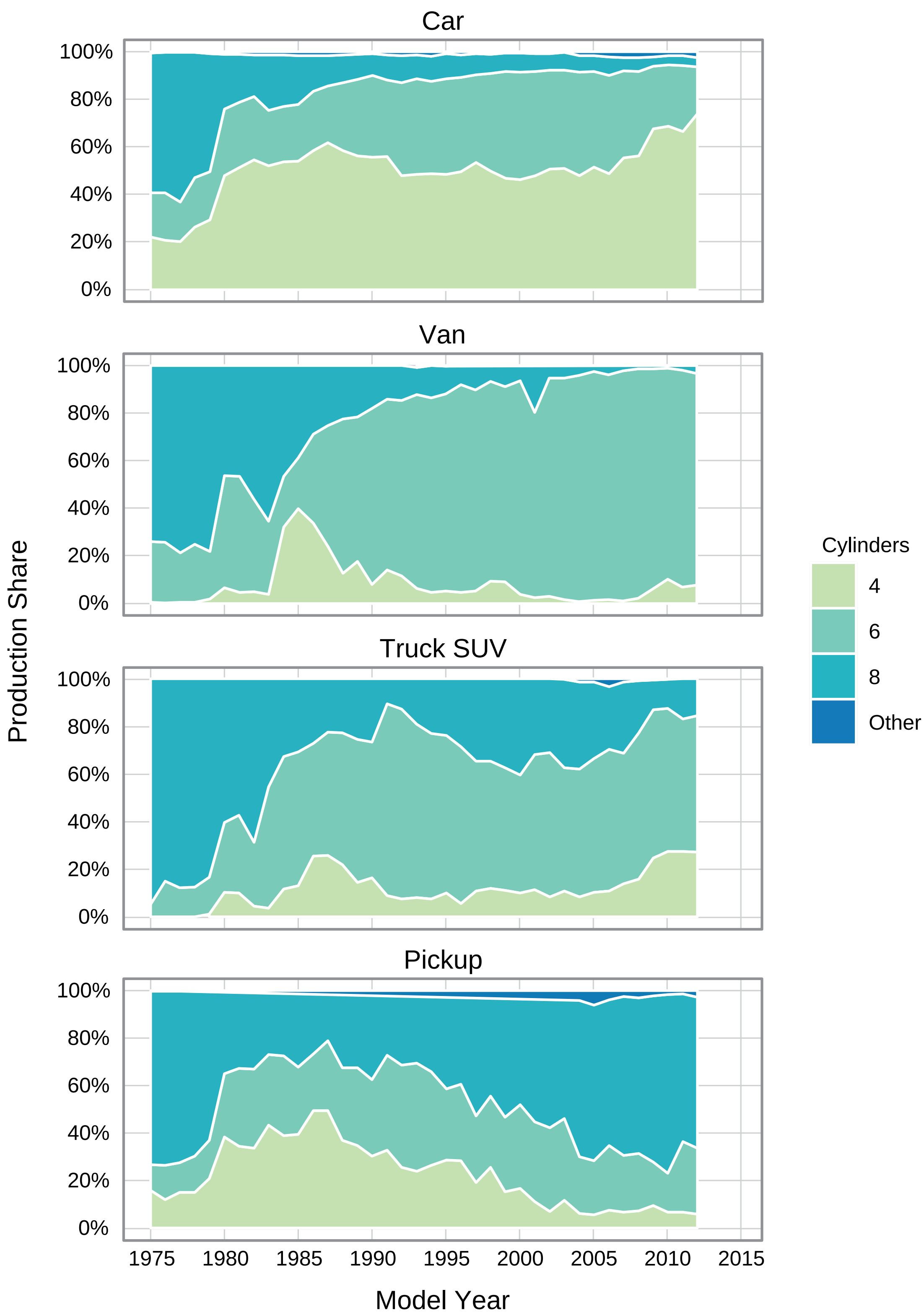


Table 17 and Figure 23 compare engine horsepower (HP), engine displacement (CID), and specific power or horsepower per cubic inch (HP/CID) for cars, vans, truck SUVs, and pickups. For all four vehicle types, significant CID reductions occurred in the late 1970s and early 1980s. Engine displacement has been relatively flat for cars and vans since the mid-1980s and has declined for truck SUVs since the mid-1990s, but has been increasing for two decades for pickups. Average horsepower has increased substantially for all of these vehicle types since MY 1981 (with a small decrease in MY 2009) with the highest increase occurring for pickups whose horsepower is now 2.7 times what it was then (i.e., 312 versus 115). Light-duty vehicle engines, thus, have also improved in specific power with the highest specific power being for engines used in passenger cars and truck SUVs. The use of cylinder deactivation has been popular in pickup trucks, now used in one-quarter of the pickup fleet.

Table 17

MY 2012 Engine Characteristics by Vehicle Type

Vehicle Type	HP	CID	HP/CID	Multi-Valve	VVT	Cylinder Deactivation
Car	192	150	1.28	98%	98%	2%
Van	259	214	1.22	95%	89%	19%
Truck SUV	261	215	1.24	87%	96%	15%
Pickup	312	285	1.11	55%	92%	25%
All	222	180	1.25	91%	97%	8%

Figure 23

Horsepower, CID, and Horsepower per CID

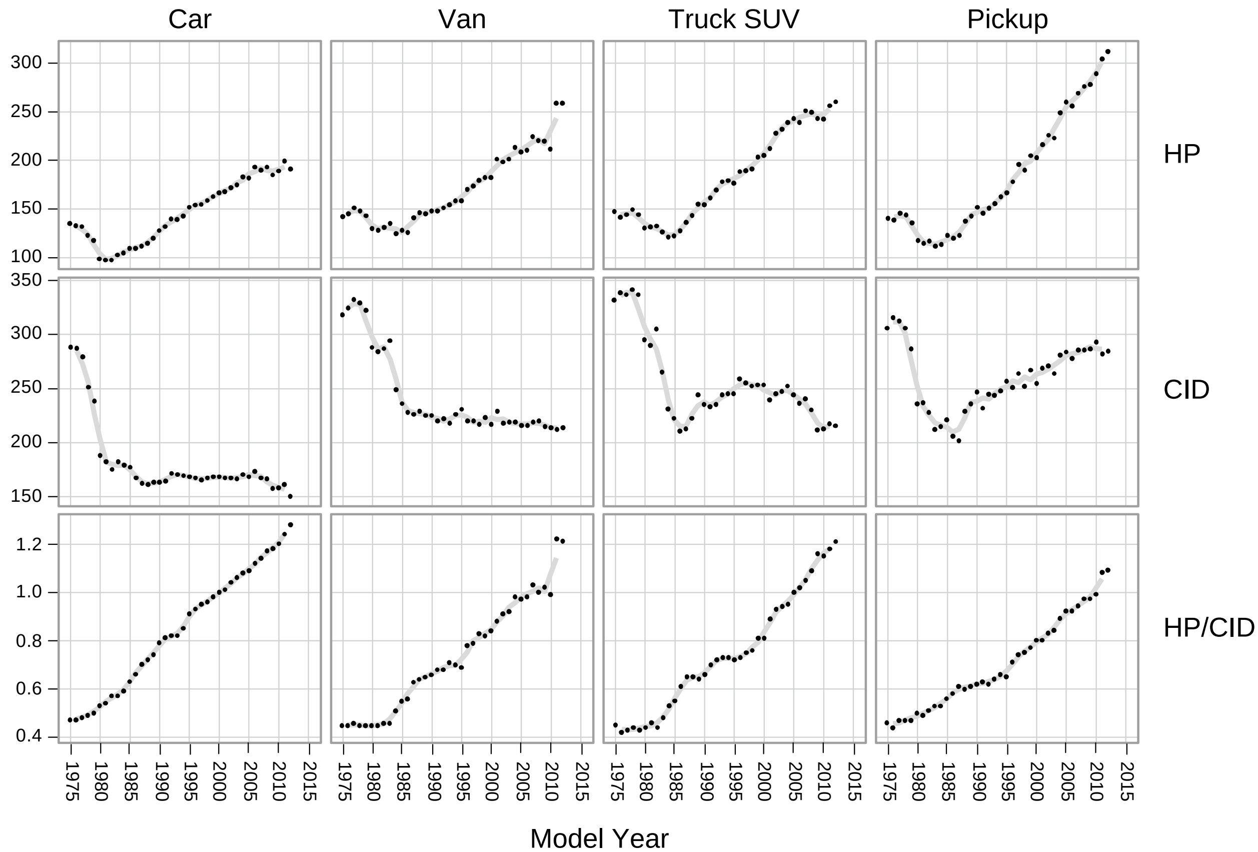


Table 18 compares HP, CID, and HP/CID by vehicle type and number of cylinders for model years 1988 and 2012. Table 18 shows that the increase in horsepower shown for the fleet in Table 13 extends to all vehicle type and cylinder number strata. These increases in horsepower range from 43 to 160%. Because displacement has remained relatively constant, it can be seen that the primary reason for the horsepower increase is increased specific power -- up between 46 and 147% from MY 1988 to 2012.

At the number-of-cylinders level of stratification, model year 2012 cars and truck SUVs generally achieve higher specific power than vans or pickups. One reason for the lower specific power of some truck engines is that these vehicles may be used to carry heavy loads or pull trailers and thus need more "torque rise," (i.e., an increase in torque as engine speed falls from the peak power point) to achieve acceptable drivability. Engines equipped with four valves per cylinder typically have inherently lower torque rise than two valve engines with lower specific power.

Table 18

Changes in Horsepower and Specific Power by Vehicle Type and Number of Cylinders

Vehicle Type	Cylinders	HP 1988	HP 2012	Percent Change	CID 1988	CID 2012	Percent Change	HP/ CID 1988	HP/ CID 2012	Percent Change
Car	4	95	157	65%	118	125	6%	0.805	1.267	57%
Car	6	142	281	98%	194	209	8%	0.743	1.349	82%
Car	8	164	426	160%	301	322	7%	0.544	1.344	147%
Van	4	98	140	43%	145	125	-14%	0.678	1.117	65%
Van	6	149	269	81%	213	217	2%	0.722	1.238	71%
Van	8	168	273	62%	322	312	-3%	0.520	0.875	68%
Truck SUV	4	94	182	94%	121	146	21%	0.775	1.255	62%
Truck SUV	6	148	274	85%	214	215	1%	0.703	1.274	81%
Truck SUV	8	183	354	93%	338	333	-1%	0.541	1.066	97%
Pickup	4	97	168	73%	142	168	19%	0.685	1.000	46%
Pickup	6	142	281	98%	229	231	1%	0.644	1.241	93%
Pickup	8	180	342	90%	329	322	-2%	0.544	1.062	95%

Table 19 shows similar data to those in Table 18, but the stratification is based on vehicle weight. This table clearly shows that, for nearly every case for which a comparison can be made between 1988 and 2012, there were increases in HP, decreases in CID, and substantial increases in specific power ranging from 41 to 255%.

Table 19

Changes in Horsepower and Specific Power by Vehicle Type and Weight

Cars

Weight (lb)	HP 1988	HP 2012	Percent Change	CID 1988	CID 2012	Percent Change	HP/CID 1988	HP/CID 2012	Percent Change
2000	59	70	19%	77	61	-21%	0.770	1.148	49%
2250	73	94	29%	90	81	-10%	0.808	1.160	44%
2500	79	105	33%	100	91	-9%	0.785	1.156	47%
2750	97	114	18%	123	94	-24%	0.804	1.212	51%
3000	114	145	27%	145	112	-23%	0.797	1.295	62%
3500	150	179	19%	212	145	-32%	0.731	1.246	70%
4000	160	259	62%	289	194	-33%	0.569	1.344	136%
4500	144	338	135%	305	250	-18%	0.474	1.377	191%
5000	207	400	93%	408	257	-37%	0.509	1.547	204%
5500	205	557	172%	412	374	-9%	0.498	1.490	199%
6000	205	556	171%	412	383	-7%	0.498	1.464	194%

Vans

Weight (lb)	HP 1988	HP 2012	Percent Change	CID 1988	CID 2012	Percent Change	HP/CID 1988	HP/CID 2012	Percent Change
3500	123	136	11%	166	122	-27%	0.736	1.115	51%
4500	169	270	60%	321	216	-33%	0.528	1.247	136%
5000	156	233	49%	312	245	-21%	0.500	0.978	96%
5500	195	294	51%	347	321	-7%	0.562	0.914	63%
6000	126	268	113%	379	318	-16%	0.332	0.843	154%

Truck SUVs

Weight (lb)	HP 1988	HP 2012	Percent Change	CID 1988	CID 2012	Percent Change	HP/CID 1988	HP/CID 2012	Percent Change
3500	149	173	16%	213	147	-31%	0.709	1.182	67%
4000	135	213	58%	190	170	-11%	0.723	1.271	76%
4500	148	267	80%	312	213	-32%	0.494	1.261	155%
5000	181	290	60%	330	221	-33%	0.545	1.314	141%
5500	200	369	84%	350	310	-11%	0.572	1.219	113%
6000	162	337	108%	368	326	-11%	0.445	1.041	134%

Pickups

Weight (lb)	HP 1988	HP 2012	Percent Change	CID 1988	CID 2012	Percent Change	HP/CID 1988	HP/CID 2012	Percent Change
3500	130	179	38%	184	176	-4%	0.719	1.015	41%
4000	154	212	38%	282	213	-24%	0.555	0.998	80%
4500	174	240	38%	322	250	-22%	0.539	0.964	79%
5000	193	271	40%	342	263	-23%	0.565	1.045	85%
5500	178	337	89%	363	315	-13%	0.495	1.080	118%
6000	140	360	157%	379	285	-25%	0.369	1.311	255%

Figure 24 shows that increases in HP per CID apply to all of the engines, except for a few cases of engines with three valves. Engines with more valves per cylinder deliver higher values of HP per CID. Engines with *only* two valves per cylinder deliver over twice as much horsepower per CID than they used to.

Figure 24

HP/CID by Number of Valves per Cylinder

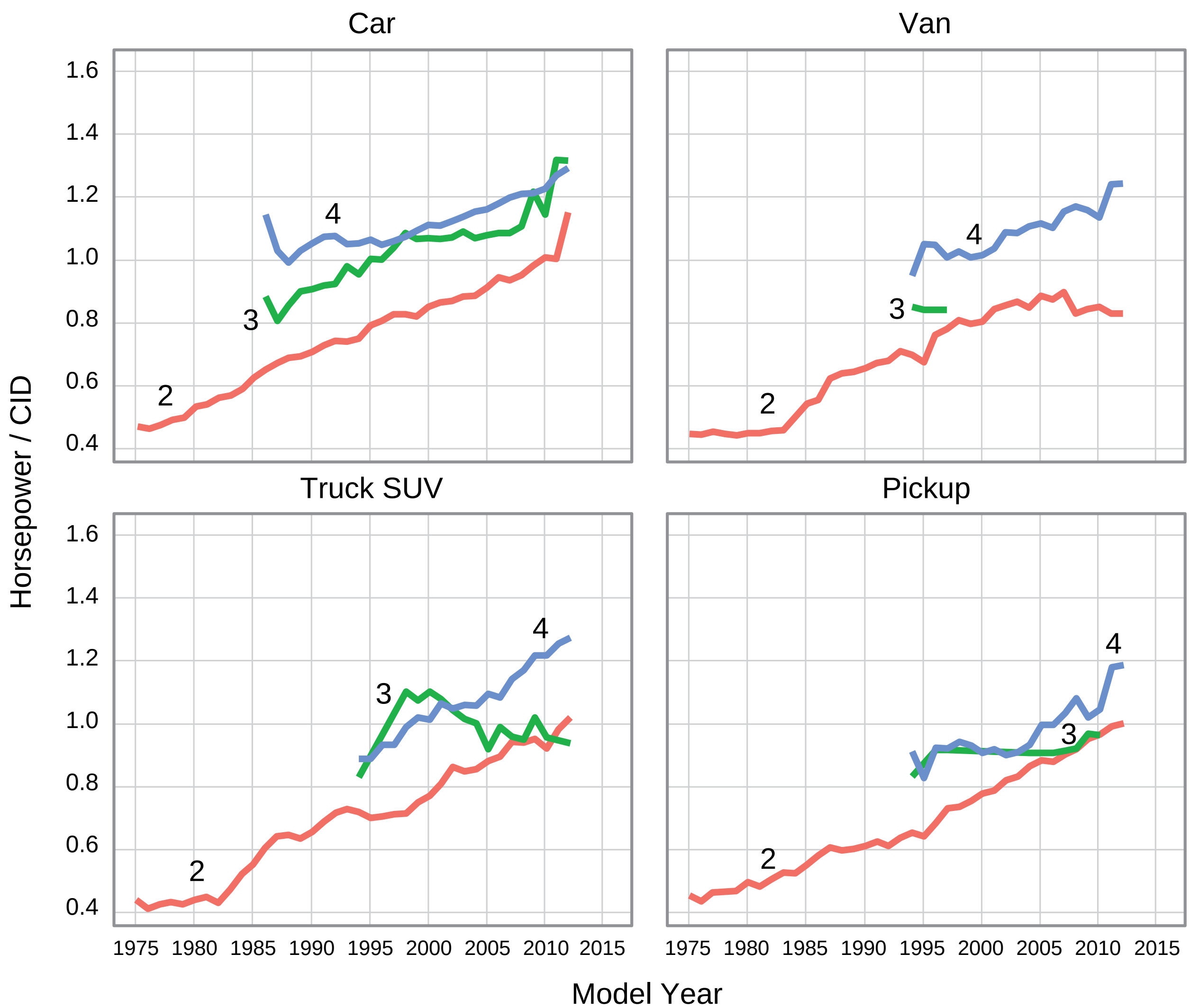


Figure 25 shows that usage of multi-valve engines continues to increase and, as shown in Table 17 for MY 2012, is now 85-95% for cars, vans and SUVs, and over 50% for pickups.

Figure 25

Production Share by Valves per Cylinder

Figure 26 and Table 20 show how the car and truck fleet have evolved from one that consisted almost entirely of carbureted engines in the 1970s and early 1980s, to one which was almost entirely port fuel injected with variable valve timing a few years ago, to one with increasing share of gasoline direct injection engines.

Figure 26

Production Share by Engine Type

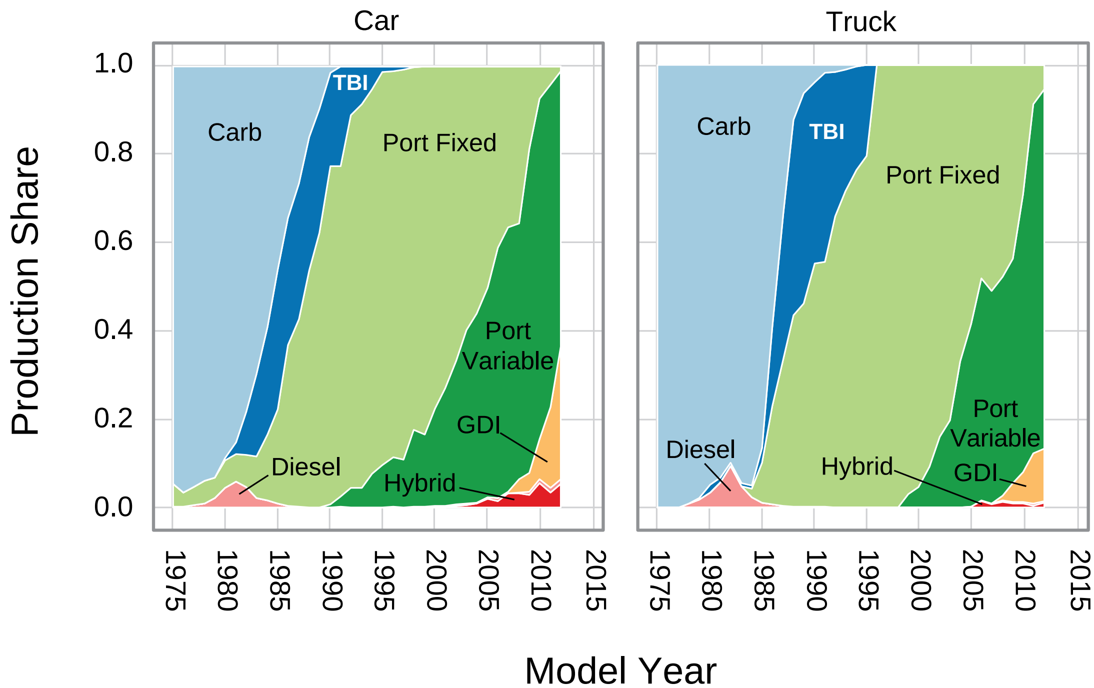


Table 20

Production Share of MY 1988 and MY 2012 Light Vehicles by Engine Type and Valve Timing

Engine Type	Cars 1988	Cars 2012	Vans 1988	Vans 2012	Truck SUVs 1988	Truck SUVs 2012	Pickups 1988	Pickups 2012	All 1988	All 2012
Carb	16%	-	0%	-	18%	-	16%	-	15%	-
TBI	30%	-	43%	-	35%	-	48%	-	34%	-
Port Fixed	54%	1%	57%	11%	47%	3%	35%	8%	51%	3%
Port Variable	-	63%	-	89%	-	79%	-	82%	-	69%
GDI Variable	-	30%	-	-	-	16%	-	10%	-	23%
Diesel	0%	1%	0%	-	0%	1%	0%	-	0%	1%
Hybrid	-	5%	-	-	-	2%	-	0%	-	4%

Table 21 compares horsepower, engine size (CID), specific power (HP/CID), Ton- mpg, and estimated 0-to-60 acceleration time for two selected MY 1988 and five MY 2012 engine types.

Table 21

Comparison of MY 1988 and MY 2012 Cars by Engine Fuel Metering, Number of Valves and Valve Timing

Fuel Metering	Number of Valves	Valve Timing	HP 1988	HP 2012	CID 1988	CID 2012	HP/CID 1988	HP/CID 2012	Ton MPG 1988	Ton MPG 2012	0-to-60 Time 1988	0-to-60 Time 2012
Carb	-	Fixed	88	-	131	-	0.75	-	37.2	-	14.3	-
TBI	4	Fixed	71	-	91	-	0.78	-	38.1	-	15.0	-
Port	2	Variable	-	368	-	353	-	1.04	-	43.1	-	6.6
Port	4	Variable	-	180	-	145	-	1.24	-	46.5	-	9.9
TBI	2	Fixed	98	-	142	-	0.71	-	36.9	-	13.7	-
GDI	4	Variable	-	220	-	154	-	1.44	-	47.5	-	8.9
Port	2	Fixed	137	389	193	312	0.74	1.19	36.6	37.3	11.9	6.9

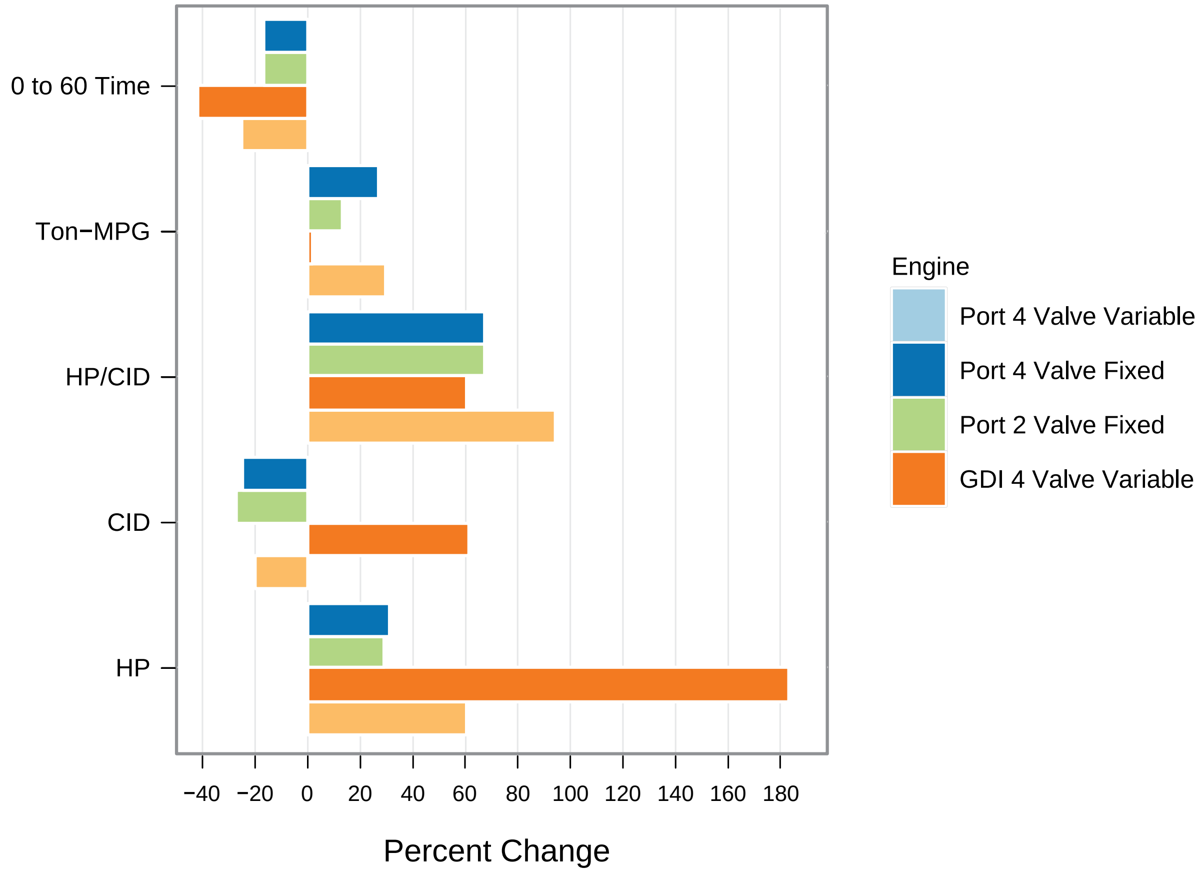
Percent Change over MY 1988 Port Two Valve, Fixed Valve Timing Base Model

Fuel Metering	Number of Valves	Valve Timing	HP 1988	HP 2012	CID 1988	CID 2012	HP/CID 1988	HP/CID 2012	Ton MPG 1988	Ton MPG 2012	0-to-60 Time 1988	0-to-60 Time 2012
Carb	-	Fixed	-35.8%	-	-32.1%	-	1.4%	-	1.6%	-	20.2%	-
TBI	4	Fixed	-48.2%	-	-52.8%	-	5.4%	-	4.1%	-	26.1%	-
Port	2	Variable	-	168.6%	-	82.9%	-	40.5%	-	17.8%	-	-44.5%
Port	4	Variable	-	31.4%	-	-24.9%	-	67.6%	-	27.0%	-	-16.8%
TBI	2	Fixed	-28.5%	-	-26.4%	-	-4.1%	-	0.8%	-	15.1%	-
GDI	4	Variable	-	60.6%	-	-20.2%	-	94.6%	-	29.8%	-	-25.2%
Port	2	Fixed	-	183.9%	-	61.7%	-	60.8%	-	1.9%	-	-42.0%

Because MY 1988 was the peak year for car fuel economy until recently, and because the two valve, fixed valve timing, port injected engine accounted for about half of the car engines built that year, the MY 1988 version of this engine was selected as a baseline engine with its average characteristics compared to four MY 2012 engine configurations. As shown in Figure 27, all of these MY 2012 engine types had substantially higher horsepower than the baseline MY 1988 engine, and substantially higher specific power. Not all of these improvements in engine design for these engine types that occurred between 1988 and 2012 were used to improve fuel economy as indicated by the nominal 20% decrease in 0-to-60 time each achieved. Obtaining increased power to weight in a time when weight is trending upwards implies that horsepower is increasing significantly.

Figure 27

Percent Difference in MY 2012 Vehicle Characteristics from MY 1988 Port/2 Valve/Fixed Valve Timing Car Engine



For the current model year fleet, specific power has been studied at an even more detailed level of stratification with both car and truck engines being classified according to: (1) the number of valves per cylinder, (2) the manufacturer's fuel recommendation, (3) the presence or absence of an intake boost device such as a turbocharger or supercharger, and (4) whether or not the engine had fixed or variable valve timing. Higher HP/CID is associated with: (a) more valves per cylinder, (b) higher octane fuel, (c) intake boost, and (d) use of variable valve timing. The technical approaches result in specific power ranges for cars and trucks from about .9 to about 1.8. The relative production fractions in Table 22 are just for each technical option in the table and exclude hybrids.

Table 22 shows the incremental effect, on a production weighted basis, of adding each technical option, but not all of the technical options are production significant. The effect of the use of higher octane fuel cannot be discounted, because roughly 15% of the current car fleet is comprised of vehicles which use engines for which high octane fuel is recommended. By comparison, about 7% of this year's light trucks require premium fuel.

Engine technology which delivers improved specific power thus can be used in many ways ranging from reduced displacement and improved fuel economy at constant (or lower) performance, to increased performance and the same fuel economy at constant displacement.

Table 22

HP/CID and Production Share by Fuel and Engine Technology

MY 2012 Cars

Fuel	Boost	Valve Timing	2 Valve HP / CID	2 Valve Production Fraction	3 Valve HP / CID	3 Valve Production Fraction	4 Valve HP / CID	4 Valve Production Fraction	Total Production Fraction
Regular	No Boost	Fixed	1.05	0.5%	-	-	1.23	0.2%	0.7%
Regular	No Boost	Variable	1.13	1.3%	1.31	0.4%	1.23	79.2%	80.9%
Regular	Boosted	Fixed	1.53	0.0%	-	-	-	-	0.0%
Regular	Boosted	Variable	-	-	-	-	1.74	3.8%	3.8%
Premium	No Boost	Fixed	1.20	0.1%	-	-	1.37	0.0%	0.2%
Premium	No Boost	Variable	1.08	0.1%	-	-	1.33	7.8%	7.9%
Premium	Boosted	Fixed	1.54	0.2%	1.64	0.0%	-	-	0.2%
Premium	Boosted	Variable	1.22	0.0%	1.56	0.0%	1.82	5.3%	5.3%
Diesel	Boosted	-	-	-	-	-	1.17	1.1%	1.1%
Total	-	-	-	2.2%	-	0.4%	-	97.3%	100.0%

MY 2012 Trucks

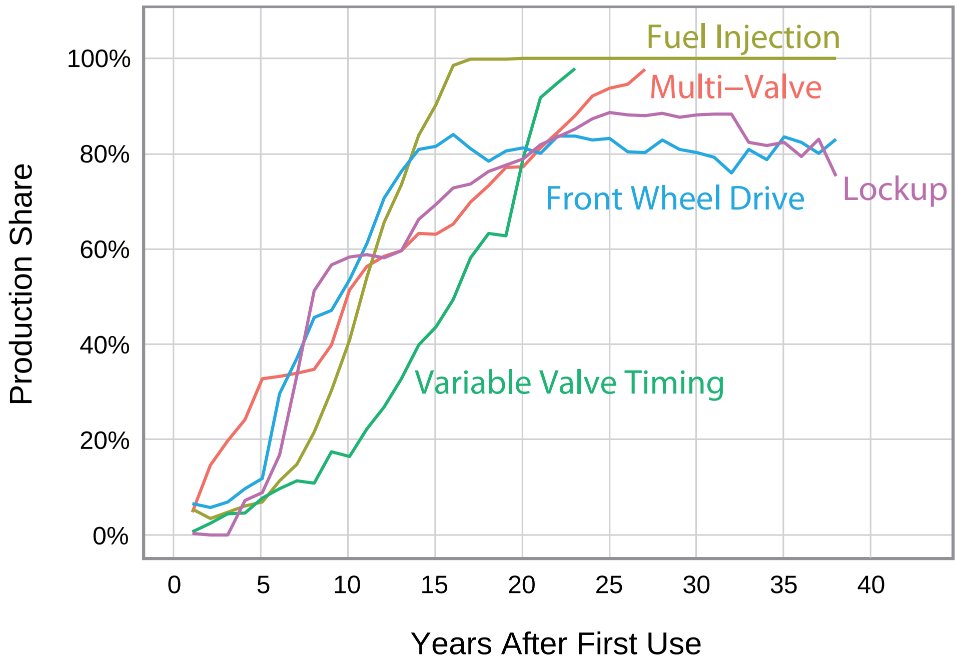
Fuel	Boost	Valve Timing	2 Valve HP / CID	2 Valve Production Fraction	3 Valve HP / CID	3 Valve Production Fraction	4 Valve HP / CID	4 Valve Production Fraction	Total Production Fraction
Regular	No Boost	Fixed	0.90	4.5%	-	-	1.11	1.0%	5.5%
Regular	No Boost	Variable	1.02	16.2%	0.94	1.2%	1.21	66.8%	84.1%
Regular	Boost	Variable	-	-	-	-	1.70	3.2%	3.2%
Premium	No Boost	Fixed	1.20	0.1%	-	-	-	-	0.1%
Premium	No Boost	Variable	-	-	-	-	1.27	4.1%	4.1%
Premium	Boost	Variable	-	-	-	-	1.81	2.5%	2.5%
Diesel	Boost	-	-	-	-	-	1.27	0.5%	0.5%
Total	-	-	-	20.7%	-	1.2%	-	78.2%	100.0%

One engine technology development that began in MY 2005 is the reintroduction of cylinder deactivation, an automotive technology that was used by General Motors in some MY 1981 V-8 engines that could be operated in 8-, 6- and 4-cylinder modes. This approach, which has also been called by a number of names including 'variable displacement', 'displacement on demand', 'active fuel management' and 'multiple displacement', involves allowing the valves of selected cylinders of the engine to remain closed and interrupting the fuel supply to these cylinders when engine power demands are below a predetermined threshold, as typically happens under less demanding driving conditions, such as steady state operation or during idle. Under light load conditions, the engine can thus provide better fuel mileage than would otherwise be achieved. Although frictional and thermodynamic energy losses still occur in the cylinders that are not being used, these losses are more than offset by the increased load and reduced specific fuel consumption of the remaining cylinders. Typically half of the usual number of cylinders is deactivated. Challenges to the engine designer for this type of engine include mode transitions, idle quality, and noise and vibration. For MY 2012, as shown previously in Table 13, it is estimated that about 8% of all vehicles are equipped with cylinder deactivation.

Figure 28 compares historical industry-wide market penetration rates for five mature passenger car technologies, namely fuel injection (summing the values for all of the individual fuel injection technologies in Table 13), front wheel drive (FWD), multi-valve engines (i.e., engines with more than two valves per cylinder), engines with variable valve timing, and lockup transmissions. Figure 28 indicates that, in the past, after the first significant use, it has often taken an additional decade for a new technology to attain an industry-wide car production fraction of 20 to 60%, and often as long as another five or ten years to reach maximum market penetration.

Figure 28

Industry-Wide Car Technology Penetration After First Significant Use



For the first time in this report, EPA is presenting a disaggregation of the above historical industry-wide technology penetration data to see what can be learned about the pace of technology deployment by individual manufacturers. For the same five technologies shown in Figure 28, Table 23 shows the maximum technology penetration rates for cars and trucks combined over 1-year, 3-year, and 5-year intervals for 13 individual manufacturers, along with the specific years associated with each value.

Table 23

Maximum Penetration Rates for Individual Manufacturers for 5 Mature Technologies

Front Wheel Drive

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	23%	1979-1980	34%	1983-1986	50%	1983-1988
Toyota	46%	1985-1986	58%	1985-1988	66%	1983-1988
Ford	23%	1980-1981	39%	1979-1982	42%	1977-1982
Honda	N/A	N/A	N/A	N/A	N/A	N/A
Chrysler-Fiat	30%	1980-1981	57%	1978-1981	70%	1977-1982
Nissan	29%	1984-1985	53%	1980-1983	71%	1978-1983
Hyundai	2%	2010-2011	2%	2008-2011	2%	2006-2011
Kia	9%	2000-2001	12%	2008-2011	17%	2005-2010
BMW	15%	2011-2012	19%	2002-2005	28%	2000-2005
VW	N/A	N/A	N/A	N/A	N/A	N/A
Subaru	31%	1991-1992	31%	1989-1992	31%	1987-1992
Daimler	48%	1982-1983	54%	1981-1984	54%	1979-1984
Mazda	36%	1980-1981	59%	1980-1983	75%	1979-1984
Maximum	48%		59%		75%	

Fuel Injection

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	17%	1984-1985	42%	1984-1987	61%	1984-1989
Toyota	34%	1989-1990	48%	1988-1991	53%	1981-1986
Ford	28%	1986-1987	65%	1982-1985	96%	1982-1987
Honda	29%	1985-1986	61%	1987-1990	91%	1985-1990
Chrysler-Fiat	27%	1987-1988	53%	1983-1986	74%	1983-1988
Nissan	40%	1987-1988	49%	1985-1988	68%	1983-1988
Hyundai	84%	1989-1990	100%	1987-1990	100%	1986-1991
Kia	N/A	N/A	N/A	N/A	N/A	N/A
BMW	55%	1976-1977	55%	1975-1978	58%	1976-1981
VW	36%	1976-1977	65%	1976-1979	65%	1976-1981
Subaru	26%	1989-1990	55%	1984-1987	74%	1983-1988
Daimler	N/A	N/A	N/A	N/A	N/A	N/A
Mazda	94%	1985-1986	99%	1983-1986	100%	1982-1987
Maximum	94%		99%		100%	

Lockup

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	39%	1980-1981	86%	1979-1982	93%	1978-1983
Toyota	27%	1983-1984	41%	1983-1986	57%	1982-1987
Ford	22%	1981-1982	44%	1979-1982	56%	1978-1983
Honda	23%	1982-1983	37%	1982-1985	51%	1982-1987
Chrysler-Fiat	53%	1977-1978	65%	1986-1989	71%	1985-1990
Nissan	15%	1982-1983	39%	1980-1983	48%	1980-1985
Hyundai	37%	1986-1987	53%	1986-1989	53%	1986-1991
Kia	11%	1994-1995	14%	1993-1996	24%	1993-1998
BMW	47%	1984-1985	49%	1983-1986	73%	1984-1989
VW	38%	2010-2011	38%	2008-2011	48%	1989-1994
Subaru	28%	1982-1983	33%	1981-1984	39%	1988-1993
Daimler	83%	1996-1997	100%	1994-1997	100%	1992-1997
Mazda	23%	1987-1988	49%	1986-1989	50%	1984-1989
Maximum	83%		100%		100%	

Multi-Valve

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	17%	2011-2012	27%	2009-2012	46%	2007-2012
Toyota	N/A	N/A	N/A	N/A	N/A	N/A
Ford	24%	2004-2005	39%	2004-2007	59%	2004-2009
Honda	N/A	N/A	N/A	N/A	N/A	N/A
Chrysler-Fiat	45%	1994-1995	64%	1993-1996	77%	1992-1997
Nissan	9%	1989-1990	18%	1989-1992	23%	1991-1996
Hyundai	46%	1993-1994	99%	1991-1994	99%	1989-1994
Kia	2%	1995-1996	2%	1993-1996	2%	1993-1998
BMW	53%	1990-1991	95%	1990-1993	98%	1989-1994
VW	26%	1997-1998	41%	1996-1999	55%	1996-2001
Subaru	59%	1994-1995	59%	1992-1995	59%	1990-1995
Daimler	33%	1993-1994	83%	1991-1994	99%	1989-1994
Mazda	19%	1993-1994	25%	1991-1994	40%	1989-1994
Maximum	59%		95%		99%	

VVT

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	22%	2006-2007	53%	2006-2009	80%	2005-2010
Toyota	38%	1999-2000	75%	1999-2002	90%	1998-2003
Ford	43%	2009-2010	79%	2008-2011	95%	2007-2012
Honda	34%	1997-1998	43%	1996-1999	65%	1997-2002
Chrysler-Fiat	38%	2006-2007	49%	2009-2012	81%	2006-2011
Nissan	34%	1990-1991	52%	1989-1992	52%	1987-1992
Hyundai	53%	2008-2009	65%	2007-2010	65%	2005-2010
Kia	57%	2009-2010	78%	2008-2011	78%	2006-2011
BMW	49%	1991-1992	72%	1989-1992	77%	1991-1996
VW	62%	2009-2010	70%	2007-2010	70%	2005-2010
Subaru	56%	2009-2010	87%	2007-2010	87%	2005-2010
Daimler	43%	2009-2010	73%	2007-2010	73%	2005-2010
Mazda	43%	2003-2004	76%	2002-2005	98%	2002-2007
Maximum	62%		87%		98%	

One important caveat with Table 23 is that, in some cases, individual manufacturers were already at extremely high rates of adoption of some technologies before Trends started collecting data for that technology (for example, Honda had essentially incorporated front wheel drive throughout its entire fleet when EPA starting monitoring front wheel drive data in 1975, and Toyota was using multi-valve engines throughout its fleet when EPA starting monitoring multi-valve data in the mid-1980s). Data for "rates of increase" in these and similar cases are meaningless and are represented as "N/A" in Table 23.

Table 23 shows that individual manufacturers adopted these older technologies at different rates. In the least aggressive cases for individual manufacturers, the maximum 1-year increases were in the 10-20% range, and the fastest 5-year increases were in the 40-50% range. In other cases, some larger manufacturers increased technology share by as much as 30-50% in a single year (some smaller manufacturers had even higher increases) and by as much as 90-95% over a 5-year interval.

Interestingly, all of the data in Table 23 suggest much more rapid technology penetration rates for individual manufacturers than for the industry as a whole. Clearly, these faster technology penetration rates by some individual manufacturers in Table 24 have been masked by EPA's past presentation of the much slower industry-wide technology penetration rates as shown in Figure 28. In combination, Figure 28 and Table 23 show a historic technology penetration paradigm with much faster technology penetration cycles by some individual manufacturers (with some major manufacturers sometimes adopting technologies across the bulk of their fleets within 5 years), along with individual manufacturers choosing to adopt the same technologies at different times. This sequencing of individual manufacturer technology penetration cycles, i.e., starting at different times, led to slower technology penetration cycles for the industry as a whole.

Table 24 shows similar manufacturer-specific combined car and truck data for three emerging technologies that are projected to have more than 10% industry-wide production share in MY 2012: 6-speed transmissions (59% share), gasoline direct injection (24% share), and continuously variable transmissions (10% share).

Table 24

Maximum Penetration Rates for Individual Manufacturers for 3 Emerging Technologies

Direct Injection Gasoline

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	28%	2009-2010	55%	2009-2012	58%	2007-2012
Toyota	2%	2008-2009	3%	2008-2011	4%	2006-2011
Ford	39%	2011-2012	40%	2009-2012	40%	2007-2012
Honda	0%	N/A	0%	N/A	0%	N/A
Chrysler-Fiat	0%	N/A	0%	N/A	0%	N/A
Nissan	7%	2010-2011	7%	2008-2011	7%	2006-2011
Hyundai	53%	2010-2011	62%	2009-2012	62%	2007-2012
Kia	34%	2011-2012	51%	2009-2012	51%	2007-2012
BMW	33%	2011-2012	41%	2009-2012	64%	2007-2012
VW	48%	2007-2008	49%	2006-2009	49%	2004-2009
Subaru	0%	N/A	0%	N/A	0%	N/A
Daimler	73%	2011-2012	74%	2009-2012	74%	2007-2012
Mazda	13%	2011-2012	13%	2009-2012	16%	2007-2012
Maximum	73%		74%		74%	

6-Speed Transmission

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	31%	2009-2010	80%	2009-2012	95%	2007-2012
Toyota	22%	2010-2011	41%	2008-2011	46%	2006-2011
Ford	18%	2009-2010	48%	2008-2011	70%	2007-2012
Honda	4%	2011-2012	6%	2009-2012	6%	2007-2012
Chrysler-Fiat	19%	2010-2011	36%	2009-2012	42%	2007-2012
Nissan	37%	2011-2012	37%	2009-2012	37%	2007-2012
Hyundai	69%	2010-2011	88%	2008-2011	90%	2006-2011
Kia	67%	2010-2011	100%	2009-2012	100%	2007-2012
BMW	38%	2005-2006	62%	2003-2006	82%	2001-2006
VW	35%	2005-2006	73%	2003-2006	82%	2002-2007
Subaru	7%	2003-2004	7%	2001-2004	7%	1999-2004
Daimler	2%	2000-2001	3%	1999-2002	3%	1997-2002
Mazda	13%	2011-2012	23%	2003-2006	28%	2002-2007
Maximum	38%		80%		95%	

CVT

Manufacturer	1-year		3-year		5-year	
	% change	Timespan	% change	Timespan	% change	Timespan
GM	2%	2002-2003	2%	2000-2003	2%	1998-2003
Toyota	9%	2009-2010	11%	2009-2012	15%	2003-2008
Ford	4%	2004-2005	6%	2003-2006	6%	2001-2006
Honda	4%	2009-2010	4%	2009-2012	4%	2007-2012
Chrysler-Fiat	28%	2006-2007	28%	2004-2007	28%	2002-2007
Nissan	63%	2006-2007	68%	2006-2009	70%	2005-2010
Hyundai	0%	N/A	0%	N/A	0%	N/A
Kia	0%	N/A	0%	N/A	0%	N/A
BMW	3%	2004-2005	6%	2002-2005	7%	2000-2005
VW	2%	2002-2003	4%	2001-2004	5%	2001-2006
Subaru	40%	2009-2010	68%	2009-2012	68%	2007-2012
Daimler	0%	N/A	0%	N/A	0%	N/A
Mazda	0%	N/A	0%	N/A	0%	N/A
Maximum	63%		68%		70%	

The data in Table 24 are much more variable. Some manufacturers have not adopted certain technologies whatsoever, while other manufacturers have 1-year technology share growth rates as high as 60-70%, and some larger manufacturers have 5-year technology share growth rates as high as 70-95%. Like the data in Table 23, the data in Table 24 on emerging technologies suggest a sequencing of individual manufacturer technology penetration cycles.

Table 25 compares fuel economy ratings, the ratio of highway to city fuel economy, and ton-mpg of the MY 2012 diesel and hybrid vehicles with those for the average MY 2012 car and truck. Most of the hybrid vehicles in the table have a lower highway/city ratio than the average car or truck. In addition, there are several cases in the table for which the highway to city ratio is less than 1.0, and these represent cases where a vehicle achieves higher fuel economy in city than in highway driving. This year's diesel cars achieve ton-mpg values that are roughly the same as some of the hybrid cars. For MY 2012, the Toyota Prius has the highest adjusted composite fuel economy value for any hybrid of 49.3 mpg and several diesel vehicles have adjusted composite fuel economy values of 35-36 mpg. The Prius achieves 86 ton-mpg, which is 78% higher than that of the average car.

Most of the vehicles in Table 25 have conventionally powered counterparts. Tables 26 and 27 compare the adjusted composite fuel economy and an estimate of annual fuel usage (assuming 15,000 miles per year) for these vehicles with their conventionally powered (baseline) counterparts. The comparisons in both tables are limited to a basis of model name, drive, weight, transmission, and engine size (CID). Differences in the performance attributes of these vehicles complicate the analysis of the fuel economy improvement potential due to hybridization and dieselization. In particular, hybrid vehicles are sometimes reported to have faster 0-to-60 acceleration times than their conventional counterparts, while vehicles equipped with diesel engines often have higher low-end torque, but slower 0-to-60 times. In addition, some hybrid vehicles use technologies such as cylinder deactivation and CVT transmissions that are not offered in their counterparts.

Fuel economy improvements for the hybrid vehicles in Table 26 vary considerably from 5-10% for the larger, luxury hybrid vehicles to over 40%. Similarly, Table 27 shows fuel economy improvements for diesels range from 10% to 40%.

Table 25

Characteristics of MY 2012 Diesel and Hybrid Vehicles

Diesel Cars

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
A3	A6	3500	120	46.1	29.8	41.5	35.5	62.2	1.4
E 350 BLUETEC	L7	4500	182	33.3	21.5	32.4	26.6	59.8	1.5
GOLF	A6	3500	120	46.1	29.8	41.5	35.5	62.2	1.4
GOLF	M6	3500	120	46.1	29.7	41.9	35.6	62.3	1.4
Jetta	A6	3500	120	46.1	29.8	41.5	35.5	62.2	1.4
Jetta	M6	3500	120	46.1	29.7	41.9	35.6	62.3	1.4
JETTA SPORTWAGEN	A6	3500	120	44.2	28.9	39.5	34.1	59.6	1.4
JETTA SPORTWAGEN	M6	3500	120	46.1	29.7	41.9	35.6	62.3	1.4
Passat	A6	3500	120	44.6	30.5	40.2	35.3	61.9	1.3
Passat	M6	3500	120	46.4	30.8	42.6	36.6	64.0	1.4
S 350 BLUETEC 4MATIC	L7	5000	182	32.3	20.9	31.4	25.8	64.6	1.5
Fleetwide Cars		**3482**	**150**	**34.6**	**22.9**	**31.8**	**27.3**	**48.3**	**1.4**

Hybrid Cars

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
ActiveHybrid 5	L8	4500	183	33.2	22.8	30.3	26.5	59.7	1.3
ActiveHybrid 7	L8	5000	269	25.6	17.2	24.1	20.5	51.3	1.4
ActiveHybrid 7L	L8	5000	269	25.6	17.2	24.1	20.5	51.3	1.4
CAMRY HYBRID LE	CVT	3500	152	57.4	42.7	39.4	40.8	71.4	0.9
CAMRY HYBRID XLE	CVT	4000	152	54.8	40.5	38.4	39.3	78.5	0.9
CIVIC HYBRID	CVT	3000	92	63.1	43.9	44.5	44.2	66.4	1.0
CR-Z	CVT	3000	92	50.1	34.8	39.1	37.1	55.7	1.1
CR-Z	M6	3000	92	44.9	31.3	36.7	34.2	51.2	1.2
CT 200h	CVT	3500	110	57.5	42.8	40.2	41.3	72.2	0.9
ESCAPE HYBRID FWD	CVT	4000	153	44.1	34.0	30.5	31.9	63.9	0.9
FUSION HYBRID FWD	CVT	4000	153	54.2	41.4	36.4	38.4	76.8	0.9
HS 250h	CVT	4000	144	47.3	35.4	33.6	34.3	68.7	1.0
INSIGHT	CVT	3000	79	58.9	40.8	44.3	42.7	64.1	1.1
LACROSSE	L6	4000	146	38.0	24.5	35.9	29.9	59.8	1.5
LS 600h L	CVT	5500	303	26.9	18.6	23.3	21.0	57.7	1.3
M35h	L7	4500	214	38.8	26.8	32.2	29.6	66.7	1.2
MKZ HYBRID FWD	CVT	4000	153	54.2	41.4	36.4	38.4	76.8	0.9
OPTIMA HYBRID	A6	3500	146	N/A	34.0	39.0	36.7	64.2	1.1
Panamera S Hybrid	L8	4500	183	34.4	22.3	30.3	26.3	59.1	1.4
PRIUS	CVT	3500	110	70.7	50.7	48.2	49.3	86.2	0.9
PRIUS c	CVT	2750	91	70.7	52.5	46.3	48.8	67.1	0.9
PRIUS v	CVT	3500	110	58.7	43.5	40.2	41.6	72.8	0.9
REGAL	L6	4000	146	38.0	24.5	35.9	29.9	59.8	1.5
RX 450h	CVT	5000	211	40.4	31.5	27.9	29.4	73.4	0.9
S400 HYBRID	L7	5000	213	27.5	18.6	25.1	21.9	54.6	1.3
SONATA HYBRID	A6	3500	146	N/A	34.0	39.0	36.7	64.2	1.1
Fleetwide Cars		**3482**	**150**	**34.6**	**22.9**	**31.8**	**27.3**	**48.3**	**1.4**

Table 25 (continued)

Diesel Trucks

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
GL 350 BLUETEC 4MATIC	L7	6000	182	24.7	16.9	21.4	19.2	57.6	1.3
ML 350 BLUETEC 4MATIC	L7	5500	182	29.4	19.7	26.9	23.3	64.0	1.4
Q7	L8	6000	181	26.0	17.5	24.9	21.1	63.2	1.4
R 350 BLUETEC 4MATIC	L7	5500	182	26.5	17.9	22.9	20.4	56.2	1.3
TOUAREG	L8	5000	181	28.9	19.1	27.9	23.3	58.2	1.5
X5 xDrive35d	L6	5500	183	28.1	18.8	26.1	22.4	61.6	1.4
Fleetwide Trucks		**4779**	**234**	**24.3**	**16.4**	**22.5**	**19.4**	**46.5**	**1.4**

Hybrid Trucks

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
C15 SIERRA 2WD HYBRID	CVT	6000	366	28.5	19.8	22.9	21.5	64.4	1.2
C15 SILVERADO 2WD HYBRID	CVT	6000	366	28.5	19.8	22.9	21.5	64.4	1.2
C1500 TAHOE 2WD HYBRID	CVT	6000	366	28.5	19.8	22.9	21.5	64.4	1.2
C1500 YUKON 2WD HYBRID	CVT	6000	366	28.5	19.8	22.9	21.5	64.4	1.2
Cayenne S Hybrid	L8	5500	183	28.1	19.9	23.8	21.9	60.3	1.2
ESCALADE 2WD HYBRID	CVT	6000	366	28.5	19.8	22.9	21.5	64.4	1.2
ESCALADE 4WD HYBRID	CVT	6500	366	28.0	20.0	23.3	21.7	70.6	1.2
ESCAPE HYBRID AWD	CVT	4000	153	39.0	30.4	27.2	28.5	57.0	0.9
HIGHLANDER HYBRID 4WD	CVT	5000	211	38.5	27.6	27.6	27.6	69.0	1.0
K15 SIERRA 4WD HYBRID	CVT	6000	366	28.4	19.7	22.7	21.3	63.9	1.2
K15 SILVERADO 4WD HYBRID	CVT	6000	366	28.4	19.7	22.7	21.3	63.9	1.2
K1500 TAHOE 4WD HYBRID	CVT	6000	366	28.4	19.7	22.7	21.3	63.9	1.2
K1500 YUKON 4WD HYBRID	CVT	6000	366	28.4	19.7	22.7	21.3	63.9	1.2
K1500 YUKON DENALI HYBRID 4WD	CVT	6500	366	28.0	20.0	23.3	21.7	70.6	1.2
RX 450h AWD	CVT	5000	211	38.6	29.5	27.6	28.4	70.9	0.9
Touareg Hybrid	L8	5500	183	28.2	19.9	23.8	21.9	60.3	1.2
Fleetwide Trucks		**4779**	**234**	**24.3**	**16.4**	**22.5**	**19.4**	**46.5**	**1.4**

Table 26

Comparison of MY 2012 Hybrid Vehicles with Their Conventional Counterparts

	Hybrid					Baseline					Improvement	
Model Name	Weight (lb)	CID	Trans	Adj Comp MPG	Gal per Year*	Weight (lb)	CID	Trans	Adj Comp MPG	Gal per Year*	Adj Comp MPG	Gal per Year*
ActiveHybrid 5	4500	183	L8	26.5	565	4500	183	L8	24.8	606	7%	41
ActiveHybrid 7	5000	269	L8	20.5	731	4500	269	L6	18.0	832	14%	101
ActiveHybrid 7L	5000	269	L8	20.5	731	5000	269	L6	17.8	844	16%	114
C15 SIERRA 2WD HYBRID	6000	366	CVT	21.5	699	5500	378	L6	15.0	1002	43%	303
C15 SILVERADO 2WD HYBRID	6000	366	CVT	21.5	699	5500	378	L6	15.0	1002	43%	303
C1500 TAHOE 2WD HYBRID	6000	366	CVT	21.5	699	6000	323	L6	17.9	840	20%	141
C1500 YUKON 2WD HYBRID	6000	366	CVT	21.5	699	6000	323	L6	17.9	840	20%	141
CAMRY HYBRID LE	3500	152	CVT	40.8	368	3500	152	L6	29.6	507	38%	139
CAMRY HYBRID XLE	4000	152	CVT	39.3	382	3500	152	L6	29.6	507	33%	125
Cayenne S Hybrid	5500	183	L8	21.9	684	5000	220	L8	19.3	777	13%	93
CIVIC HYBRID	3000	92	CVT	44.2	339	3000	110	L5	33.3	450	33%	111
ESCALADE 2WD HYBRID	6000	366	CVT	21.5	699	6000	378	L6	16.1	934	34%	235
ESCALADE 4WD HYBRID	6500	366	CVT	21.7	690	6000	378	L6	15.3	984	43%	293
ESCAPE HYBRID AWD	4000	153	CVT	28.5	526	4000	183	L6	20.5	730	39%	204
ESCAPE HYBRID FWD	4000	153	CVT	31.9	470	3500	153	L6	24.2	621	32%	151
FUSION HYBRID FWD	4000	153	CVT	38.4	391	4000	153	L6	27.6	544	39%	153
HIGHLANDER HYBRID 4WD	5000	211	CVT	27.6	544	4500	211	L5	19.5	771	42%	227
K15 SIERRA 4WD HYBRID	6000	366	CVT	21.3	704	6000	378	L6	14.7	1017	45%	313
K15 SILVERADO 4WD HYBRID	6000	366	CVT	21.3	704	6000	378	L6	14.8	1016	44%	312
K1500 TAHOE 4WD HYBRID	6000	366	CVT	21.3	704	6000	323	L6	17.6	852	21%	148
K1500 YUKON 4WD HYBRID	6000	366	CVT	21.3	704	6000	323	L6	17.6	852	21%	148
K1500 YUKON DENALI HYBRID 4WD	6500	366	CVT	21.7	690	6000	378	L6	15.3	984	43%	293
LACROSSE	4000	146	L6	29.9	501	4000	220	L6	21.8	688	37%	187
LS 600h L**	5500	303	CVT	21.0	714	4500	281	L8	20.1	748	5%	34
MKZ HYBRID FWD	4000	153	CVT	38.4	391	4000	153	L6	27.6	544	39%	153
OPTIMA HYBRID	3500	146	A	36.7	400	3500	146	L6	29.0	518	27%	108
Panamera S Hybrid	4500	183	L8	26.3	571	4000	220	L7	22.1	679	19%	108
REGAL	4000	146	SL	29.9	501	4000	146	L6	24.7	608	21%	106
RX 450h AWD**	5000	211	CVT	28.4	529	4500	211	L6	20.7	723	37%	195
RX 450h**	5000	211	CVT	29.4	511	4500	211	L6	21.5	698	37%	187
S400 HYBRID**	5000	213	L7	21.9	686	5000	285	L7	18.7	801	17%	114
SONATA HYBRID	3500	146	A	36.7	399	3500	146	L6	28.9	520	27%	108
Touareg Hybrid	5500	183	L8	21.9	684	5000	219	L8	19.5	768	12%	84

*Note: Gallons per year calculation is based on all vehicles being driven 15,000 miles.

** Note: Baseline vehicle used for the GS 450h comparison is the GS 350. Baseline vehicle used for the LS 600HL comparison is the LS 460L. Baseline vehicles used for the Rx 450h and Rx 450h AWD comparison were the Rx 350 and the Rx 350 AWD. Baseline vehicle used for the S400 comparison is the S550 4MATIC. Baseline vehicle used for the MKZ Hybrid is the Fusion. Baseline vehicles used for the Panamera S and Cayenne S Hybrids are the "non-S" Panamera and Cayenne vehicles, respectively.

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Table 27

Comparison of MY 2012 Diesel Vehicles with Their Conventional Counterparts

	Diesel					Baseline					Improvement	
Model Name	Weight (lb)	CID	Trans	Adj. Comp. MPG	Gal. per Year*	Weight (lb)	CID	Trans	Adj. Comp. MPG	Gal. per Year*	Adj. Comp. MPG	Gal. per Year*
X5 xDrive35d	5500	183	L6	22.40	669.78	5000	183	L8	19.36	774.60	16%	104.8
E 350 BLUETEC	4500	182	L7	26.58	564.44	4500	213	L7	23.61	635.40	13%	71.0
GL 350 BLUETEC 4MATIC**	6000	182	L7	19.19	781.51	6000	285	L7	15.09	994.10	27%	212.6
ML 350 BLUETEC 4MATIC**	5500	182	L7	23.27	644.52	5000	213	L7	20.29	739.34	15%	94.8
R 350 BLUETEC 4MATIC**	5500	182	L7	20.44	733.78	5500	213	L7	18.60	806.40	10%	72.6
S 350 BLUETEC 4MATIC**	5000	182	L7	25.84	580.53	5000	285	L7	19.60	765.46	32%	184.9
A3	3500	120	L6	35.53	422.18	3500	121	L6	24.84	603.97	43%	181.8
GOLF	3500	120	L6	35.53	422.18	3500	151	L6	27.35	548.39	30%	126.2
GOLF	3500	120	M6	35.61	421.24	3500	151	M5	27.53	544.84	29%	123.6
Jetta	3500	120	L6	35.53	422.18	3500	151	L6	27.35	548.39	30%	126.2
Jetta	3500	120	M6	35.61	421.24	3500	151	M	27.53	544.84	29%	123.6
JETTA SPORTWAGEN	3500	120	L6	34.08	440.16	3500	151	L6	27.35	548.39	25%	108.2
JETTA SPORTWAGEN	3500	120	M6	35.61	421.24	3500	151	M5	27.53	544.84	29%	123.6
Passat	3500	120	L6	35.35	424.39	3500	151	L6	26.28	570.81	35%	146.4
Passat	3500	120	M6	36.59	410.00	3500	151	M5	26.76	560.60	37%	150.6
Q7	6000	181	L8	21.06	712.32	6000	183	L8	18.46	812.37	14%	100.0
TOUAREG	5000	181	L8	23.28	644.40	5000	219	L8	19.54	767.51	19%	123.1

*Note: Gallons per year calculation is based on all vehicles being driven 15,000 miles.

**Note: Baseline version used for the R350 Bluetec comparison is the R350 4MATIC. Baseline version used for the GL350 Bluetec comparison is the GL450 4MATIC. Baseline version used for the ML350 Bluetec comparison is the ML350 4MATIC. Baseline version used for the X5 xDrive 35d comparison is the X5 xDrive 30i.

VII. Fuel Economy by Manufacturer and Make

This report groups vehicles by “manufacturer” and “make.” The initial reports in this series examined fuel economy and technology trends for the "Domestic" and "Import" vehicle categories which are part of the corporate average fuel economy (CAFE) program. Over time, this classification approach evolved into a market segment approach in which cars were apportioned to a "Domestic," "European," and "Asian" category, with trucks classified as "Domestic" or "Imported." More recent reports in this series used “Marketing Groups” to better reflect the financial arrangements and transnational nature of the modern automobile industry.

This report reflects the manufacturer definitions used by the National Highway Traffic Safety Administration (NHTSA) for purposes of implementation of and manufacturer compliance with the CAFE program. Table 28 lists the 13 manufacturers which had production of 100,000 or more gasoline and/or diesel vehicles in MY 2010 and/or MY 2011, which together accounted for approximately 98% of total industry-wide production.

Make is typically included in the model name and is generally equivalent to the “brand” of the vehicle. Table 28 also lists the 28 makes for which data are shown in Tables 29 and 30. The MY 2011 production threshold for makes to be included in Tables 28 through 30 is 40,000 vehicles, though the Smart was included as well because of the high interest in this make. The Mercury make no longer exists, but is included since Tables 29 and 30 also provide data for MY 2010 and 2011.

Table 28

Manufacturers and Makes for MY 2010-2012

Manufacturer	Makes Above Threshold	Makes Below Threshold
General Motors	Chevrolet, Cadillac, Buick, GMC	
Toyota	Toyota, Lexus, Scion	
Ford	Ford, Lincoln, Mercury	Roush, Shelby
Honda	Honda, Acura	
Chrysler-FIat	Chrysler, Dodge, Jeep, Ram	Ferrari, Maserati, Fiat
Nissan	Nissan, Infiniti	
Hyundai	Hyundai	
Kia	Kia	
BMW	BMW, Mini	Rolls Royce
Volkswagen	Volkswagen, Audi	Lamborghini, Bentley, Bugatti
Subaru	Subaru	
Daimler	Mercedes-Benz, Smart	Maybach
Mazda	Mazda	
Others*		

*Note: Other manufacturers below the manufacturer threshold are Mitsubishi, Volvo, Rover, Porsche, Suzuki, Jaguar, Spyker (Saab), Aston Martin, Lotus, VPG

It is important to note that when a manufacturer or make grouping is changed to reflect a change in the industry's current financial structure, EPA makes the same adjustment for the entire historical database back to 1975. This maintains a consistent manufacturer or make definition over time, which allows a better identification of long-term trends. On the other hand, this also means that the current database does not necessarily reflect actual financial or structural arrangements in the past. For example, the 2011 database no longer accounts for the fact that Chrysler was combined with Daimler for several years, and includes Fiat, Ferrari, and Maserati in the Chrysler-Fiat manufacturer grouping for all years even though the financial relationship is very recent.

Automakers submit vehicle production data, rather than vehicle sales data, in formal end-of-year CAFE compliance reports to EPA. Accordingly, the vehicle production data in this report may differ from sales data reported by press sources. In addition, the vehicle production data presented in this report are tabulated on a model year basis. In years past, manufacturers typically used a more consistent approach for model year designations, i.e., from fall of one year to the fall of the following year. More recently, however, many manufacturers have used a more flexible approach and it is not uncommon to see a new or redesigned model be introduced in the spring or summer, with a new model year designation, rather than the fall. This means that a model year for an individual vehicle can be either shortened or lengthened. Accordingly, year-to-year comparisons can be affected by these model year anomalies, though, of course, these even out over a multi-year period.

It is important to note that, on November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. Hyundai and Kia submitted corrected MY 2011-2013 fuel economy and CO_2 emissions data to EPA and re-labeled the majority of their model year 2012 and 2013 vehicle models on the market. This report uses the corrected fuel economy values submitted by Hyundai and Kia for four MY 2011 vehicles and for a majority of Hyundai and Kia vehicles for MY 2012. The magnitude of the changes between the original fuel economy label values and the corrected fuel economy label values ranges from 1 mpg to 6 mpg. For the changes in fuel economy label values for individual vehicles, see http://www.epa.gov/fueleconomy/labelchange.htm. Since EPA's investigation into Hyundai and Kia data submissions is continuing, Hyundai and Kia-specific values are excluded from the following tables that list the fuel economy and CO_2 emissions performance for various manufacturers, but are sometimes provided in table footnotes.

Tables 29 and 30 give laboratory and adjusted fuel economy values for cars, trucks, and cars and trucks combined for MY 2010-2012, for 11 manufacturers and 26 makes. By including data from both MY 2010 and 2011, with formal end-of-year data for both years, it is possible to identify meaningful changes from year-to-year. Because of the uncertainty associated with the MY 2012 projections, changes from MY 2011 to MY 2012 may be less meaningful.

The relative fuel economy comparisons for manufacturers and makes in Tables 29 and 30 will be similar, of course, since the relative offset between laboratory and adjusted values will be approximately similar across manufacturers and makes. The following discussion will be based on the adjusted composite fuel economy data from Table 30.

In MY 2011, 7 of the 11 manufacturers increased fuel economy and the industry reached a fleet average of 22.4 mpg. In terms of manufacturers, Volkswagen had the highest MY 2011 adjusted composite fuel economy of 26.0 mpg, followed by Mazda at 25.0 mpg and Toyota and Honda at 24.1 mpg. Daimler had the lowest MY 2011 adjusted fuel economy for any manufacturer, 19.1 mpg, and was followed by Chrysler-Fiat at 19.4 mpg and GM at 20.7 mpg. In terms of improvement from MY 2010 to MY 2011, Volkswagen had the largest improvement of 1.0 mpg, followed by Ford at 0.7 mpg.

In terms of makes in MY 2011, the Smart make had the highest fuel economy at 36.5 mpg. The Smart Fourtwo is the smallest and lightest car in the U.S. market and has relatively low production. The make with the second-highest fuel economy in MY 2011 was the Mini, which produces a relatively low number of small vehicles, at 30.3 mpg. Of the makes with higher production, for the 11 manufacturers shown, Volkswagen had the highest overall fuel economy at 27.7 mpg, followed by Scion at 26.1 mpg, and Mazda at 25.0 mpg.

Preliminary projections suggest that all of the 11 manufacturers shown will improve fuel economy further in MY 2012, though EPA will not have actual data for MY 2012 until later this year.

Table 31 shows footprint by manufacturer for MY 2010-2012, along with truck production share by manufacturer. GM, Ford, and Chrysler-Fiat had the largest footprint values in MY 2011 at 51-53 square feet, with most of the other manufacturers having average footprint values in the 45-49 square feet range. EPA is not making direct manufacturer footprint comparisons between 2010 and 2011, because we have less confidence in the MY 2010 footprint data. Chrysler-Fiat had the highest MY 2011 truck share at 77%, followed by Subaru at 67%, while Hyundai, Mazda, and BMW had the lowest truck shares, all between 8% and 17%. Industry-wide footprint and truck share are projected to drop in MY 2012.

Table 32 (actual MY 2011) and Table 33 (MY 2012 projections) show the adjusted fuel economy values broken out by manufacturer and vehicle size and type. For example, Honda had the highest small car adjusted composite fuel economy in MY 2011 at 30.5 mpg. Of course, these tables rely on the threshold definitions for small/midsize/large vehicle sizes that have been discussed earlier in this report, and a vehicle that just crosses the threshold into the next largest class can be a fuel economy leader in that class, while it may have been a relatively poor performer in the next smaller class.

For a long-term perspective going back to 1975, Figure 29 shows the adjusted fuel economy values (cars, trucks, and both cars and trucks) and truck production shares for the 13 highest-selling manufacturers. More information for the historic database stratified by manufacturer can be found in Appendices L through P.

Table 29

Laboratory 55/45 Fuel Economy by Manufacturer and Make for MY 2010--2012

Manufacturer	Make	2010 Cars	2010 Trucks	2010 Cars and Trucks	2011 Cars	2011 Trucks	2011 Cars and Trucks	2012 Cars	2012 Trucks	2012 Cars and Trucks
VW	VW	34.4	26.0	33.5	35.4	27.7	34.1	34.5	29.2	33.9
VW	Audi	29.7	24.6	28.0	29.7	26.6	28.7	29.3	26.5	28.5
VW	**All**	**33.1**	**25.2**	**31.7**	**33.5**	**27.1**	**32.1**	**33.2**	**28.0**	**32.3**
Mazda	**All**	**32.8**	**25.2**	**30.9**	**33.4**	**24.6**	**31.7**	**34.5**	**24.6**	**33.0**
Toyota	Toyota	40.2	24.3	33.2	37.0	24.9	30.8	41.5	24.6	33.1
Toyota	Lexus	29.4	26.6	28.3	29.7	25.6	28.3	30.9	26.3	29.3
Toyota	Scion	33.1	-	33.1	33.5	-	33.5	35.8	-	35.8
Toyota	**All**	**38.1**	**24.7**	**32.4**	**35.9**	**24.9**	**30.6**	**39.4**	**24.8**	**32.8**
Subaru	**All**	**30.2**	**29.6**	**29.7**	**30.2**	**30.4**	**30.4**	**35.0**	**30.5**	**32.1**
Honda	Honda	36.0	26.6	32.2	35.9	26.9	30.9	38.7	28.6	34.3
Honda	Acura	29.1	23.6	27.0	29.9	23.4	25.7	30.5	23.4	27.4
Honda	**All**	**35.1**	**26.2**	**31.5**	**35.4**	**26.4**	**30.4**	**37.7**	**28.0**	**33.5**
Nissan	Nissan	33.7	23.1	29.8	34.4	24.0	30.1	35.8	25.8	32.2
Nissan	Infiniti	26.4	19.8	24.6	27.1	21.0	25.4	27.6	21.4	26.6
Nissan	**All**	**32.8**	**22.8**	**29.3**	**33.3**	**23.8**	**29.6**	**34.3**	**25.5**	**31.4**
BMW	BMW	26.1	23.6	25.5	27.8	25.3	27.3	28.4	24.6	27.1
BMW	Mini	37.6	-	37.6	39.3	-	39.3	38.8	-	38.8
BMW	**All**	**28.5**	**23.6**	**27.6**	**29.1**	**25.3**	**28.4**	**30.9**	**24.6**	**29.1**
Ford	Ford	31.0	21.7	25.5	31.8	23.0	26.5	35.7	23.3	29.5
Ford	Mercury	28.7	24.1	27.7	26.7	26.8	26.7	-	-	-
Ford	Lincoln	25.6	23.7	25.1	27.6	22.0	23.6	27.6	21.9	25.7
Ford	**All**	**30.4**	**21.8**	**25.6**	**31.2**	**23.0**	**26.5**	**35.1**	**23.3**	**29.3**
GM	Chevrolet	30.7	22.1	27.2	31.0	22.0	26.5	32.1	22.3	27.3
GM	GMC	29.9	22.3	23.7	29.6	22.0	23.3	30.1	21.8	23.6
GM	Buick	26.1	24.0	25.2	27.6	23.8	26.2	30.1	24.0	29.0
GM	Cadillac	25.3	20.8	24.6	25.5	19.9	24.3	25.5	20.4	23.6
GM	**All**	**29.7**	**22.3**	**26.5**	**29.8**	**22.0**	**25.7**	**31.4**	**22.2**	**26.7**
Chrysler-Fiat	Jeep	-	23.1	23.1	-	23.9	23.9	-	23.8	23.8
Chrysler-Fiat	Dodge	27.8	23.9	25.8	28.4	24.0	25.7	28.8	24.8	26.4
Chrysler-Fiat	Chrysler	27.9	24.3	25.7	28.4	25.7	27.1	29.0	25.9	27.5
Chrysler-Fiat	Ram	-	19.7	19.7	-	19.8	19.8	-	20.4	20.4
Chrysler-Fiat	**All**	**27.7**	**22.9**	**24.3**	**28.2**	**23.2**	**24.2**	**30.8**	**23.8**	**25.7**
Daimler	Mercedes-Benz	24.5	21.4	23.4	24.9	21.1	23.6	28.3	22.5	26.7
Daimler	Smart	49.1	-	49.1	48.7	-	48.7	50.3	-	50.3
Daimler	**All**	**24.7**	**21.4**	**23.6**	**25.1**	**21.1**	**23.7**	**28.3**	**22.5**	**26.7**
Other	**All**	**28.9**	**21.6**	**25.6**	**29.9**	**22.4**	**26.3**	**29.4**	**23.9**	**27.6**
Fleet	**All**	**32.6**	**23.4**	**28.4**	**32.3**	**23.9**	**28.1**	**34.6**	**24.3**	**30.0**

*Note: Two manufacturers, Hyundai and Kia, are not included in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. EPA has not yet released formal, corrected laboratory values for Hyundai and Kia.

Table 30

Adjusted Composite Fuel Economy by Manufacturer and Make for MY 2010-2012

Manufacturer	Make	2010 Cars	2010 Trucks	2010 Cars and Trucks	2011 Cars	2011 Trucks	2011 Cars and Trucks	2012 Cars	2012 Trucks	2012 Cars and Trucks
VW	VW	27.1	20.7	26.4	28.9	22.1	27.7	28.1	22.9	27.4
VW	Audi	23.5	19.5	22.1	24.1	21.4	23.2	23.9	21.4	23.2
VW	**All**	**26.1**	**20.0**	**25.0**	**27.3**	**21.7**	**26.0**	**27.0**	**22.2**	**26.2**
Mazda	**All**	**25.8**	**20.1**	**24.4**	**26.3**	**19.6**	**25.0**	**27.0**	**19.6**	**25.9**
Toyota	Toyota	30.9	19.4	25.9	28.9	19.8	24.2	31.8	19.5	25.8
Toyota	Lexus	23.3	21.1	22.4	23.6	20.3	22.4	24.4	20.8	23.2
Toyota	Scion	25.9	-	25.9	26.1	-	26.1	27.7	-	27.7
Toyota	**All**	**29.5**	**19.6**	**25.4**	**28.1**	**19.8**	**24.1**	**30.4**	**19.6**	**25.6**
Honda	Honda	28.3	21.2	25.4	28.3	21.4	24.5	30.1	22.9	27.0
Honda	Acura	23.2	18.8	21.5	23.8	18.6	20.5	24.2	18.5	21.8
Honda	**All**	**27.6**	**20.9**	**24.9**	**27.9**	**21.1**	**24.1**	**29.4**	**22.3**	**26.4**
Subaru	**All**	**23.8**	**23.3**	**23.4**	**23.9**	**23.9**	**23.9**	**27.4**	**24.0**	**25.2**
Nissan	Nissan	26.4	18.4	23.5	26.8	19.1	23.7	27.8	20.5	25.2
Nissan	Infiniti	21.1	16.0	19.8	21.7	17.0	20.4	22.0	17.3	21.3
Nissan	**All**	**25.8**	**18.2**	**23.1**	**26.1**	**19.0**	**23.3**	**26.8**	**20.2**	**24.6**
BMW	BMW	21.1	18.9	20.6	22.4	20.3	21.9	22.5	19.8	21.6
BMW	Mini	29.2	-	29.2	30.3	-	30.3	29.9	-	29.9
BMW	**All**	**22.8**	**18.9**	**22.1**	**23.3**	**20.3**	**22.7**	**24.4**	**19.8**	**23.1**
Ford	Ford	24.6	17.4	20.3	25.2	18.4	21.1	28.0	18.7	23.4
Ford	Mercury	23.0	19.2	22.1	21.5	21.1	21.4	-	-	-
Ford	Lincoln	20.6	18.9	20.2	22.0	17.7	18.9	22.1	17.6	20.6
Ford	**All**	**24.1**	**17.5**	**20.4**	**24.8**	**18.4**	**21.1**	**27.6**	**18.6**	**23.2**
GM	Chevrolet	24.5	17.9	21.8	24.9	17.8	21.3	25.6	17.9	21.9
GM	GMC	23.9	18.0	19.1	23.6	17.7	18.7	23.8	17.5	18.9
GM	Buick	21.1	19.4	20.4	22.4	19.2	21.2	24.3	19.0	23.2
GM	Cadillac	20.3	16.9	19.8	20.5	15.6	19.5	20.5	15.7	18.6
GM	**All**	**23.8**	**18.0**	**21.3**	**24.0**	**17.8**	**20.7**	**25.1**	**17.8**	**21.4**
Chrysler-Fiat	Jeep	-	18.4	18.4	-	19.1	19.1	-	19.0	19.0
Chrysler-Fiat	Dodge	22.2	19.3	20.7	22.8	19.3	20.6	23.2	20.0	21.3
Chrysler-Fiat	Chrysler	22.3	19.7	20.6	23.0	20.8	21.9	23.4	20.9	22.1
Chrysler-Fiat	Ram	-	16.0	16.0	-	16.0	16.0	-	16.5	16.5
Chrysler-Fiat	**All**	**22.1**	**18.4**	**19.5**	**22.7**	**18.6**	**19.4**	**24.6**	**19.1**	**20.6**
Daimler	Mercedes-Benz	19.7	17.2	18.8	20.1	16.9	19.0	22.7	18.0	21.4
Daimler	Smart	36.8	-	36.8	36.5	-	36.5	36.5	-	36.5
Daimler	**All**	**19.9**	**17.2**	**18.9**	**20.2**	**16.9**	**19.1**	**22.7**	**18.0**	**21.4**
Other	**All**	**23.0**	**17.4**	**20.5**	**23.8**	**18.0**	**21.0**	**23.4**	**19.2**	**22.0**
Fleet	**All**	**25.7**	**18.8**	**22.6**	**25.6**	**19.1**	**22.4**	**27.3**	**19.4**	**23.8**

*Note: Two manufacturers, Hyundai and Kia, are not included in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. This report uses the corrected fuel economy values submitted by Hyundai and Kia for four MY 2011 vehicles and for a majority of Hyundai and Kia vehicles for MY 2012. Based on these corrected data, Hyundai's 2010 Cars and Trucks value is 27.0 mpg, Hyundai's 2011 Cars and Trucks value is 27.2 mpg, Hyundai's preliminary 2012 Cars and Trucks value is 28.8 mpg, Kia's 2010 Cars and Trucks value is 27.0 mpg, Kia's 2011 Cars and Truck values is 25.8 mpg, and Kia's preliminary 2012 Car and truck value is 26.7mpg.

Table 31

Footprint (sq ft) and Truck Share by Manufacturer for MY 2010—2012*

Manufacturer	2010 Cars	2010 Trucks	2010 Cars and Trucks	2010 Percent Trucks	2011 Cars	2011 Trucks	2011 Cars and Trucks	2011 Percent Trucks	2012 Cars	2012 Trucks	2012 Cars and Trucks	2012 Percent Trucks
GM	46.8	59.6	51.5	36.8%	47.2	61.0	53.4	44.9%	47.0	60.2	52.6	42.0%
Toyota	44.3	53.2	47.2	32.1%	45.5	53.4	48.6	39.5%	44.8	53.9	47.9	33.8%
Ford	46.1	58.3	51.9	47.7%	46.1	58.2	52.1	50.0%	44.5	59.7	50.4	39.0%
Honda	44.8	49.6	46.4	33.5%	45.1	49.7	47.4	48.9%	44.9	50.4	46.9	36.0%
Chrysler-Fiat	48.9	51.8	50.9	66.7%	49.0	52.6	51.8	77.4%	46.0	52.5	50.4	67.4%
Nissan	45.4	51.6	47.1	27.6%	45.0	51.2	47.0	31.6%	44.6	51.7	46.5	27.1%
Hyundai	45.0	46.9	45.1	7.5%	47.0	46.7	47.0	8.1%	45.5	47.4	45.5	4.4%
Kia	43.8	52.4	44.6	8.8%	45.4	48.3	45.9	19.0%	44.5	48.7	45.1	13.4%
BMW	44.9	50.7	45.8	15.7%	45.9	51.1	46.8	17.0%	46.0	51.2	47.3	24.3%
VW	43.7	47.9	44.3	14.4%	44.4	47.8	45.1	19.5%	45.3	48.1	45.6	13.8%
Subaru	44.2	44.1	44.1	71.8%	44.2	44.8	44.6	67.4%	43.7	44.6	44.2	61.5%
Daimler	47.6	50.7	48.6	32.0%	46.4	51.9	48.1	31.1%	46.1	51.5	47.3	23.0%
Mazda	44.6	48.6	45.4	19.8%	44.3	50.5	45.3	15.5%	44.1	50.9	44.9	11.1%
Other	44.8	48.1	46.1	38.3%	45.2	48.2	46.4	41.2%	45.9	48.1	46.5	28.7%
All	45.4	53.8	48.6	37.3%	46.0	54.4	49.5	42.2%	45.3	54.5	48.6	36.1%

*Note: all footprint values for MY 2011 and later are based on formal manufacturer data, and are based on different data sources than values for MY 2010 and earlier.

Table 32

MY 2011 Adjusted Composite Fuel Economy by Vehicle Type and Size for Largest Manufacturers

Vehicle Type/Size	GM	Toyota	Ford	Honda	Chrysler-Fiat	Nissan	BMW	VW	Subaru	Daimler	Mazda	All
Cars												
Small	22.5	29.7	28.2	30.5	20.3	23.3	23.4	27.2	22.0	20.8	27.5	26.2
Midsize	25.1	28.8	26.3	21.5	24.3	27.0	24.4	21.0	25.6	20.2	25.2	26.6
Large	22.9	24.0	20.9	27.2	21.0	-	18.6	21.7	-	18.0	-	24.2
All Sizes	24.1	28.7	25.5	28.5	22.3	26.4	23.3	26.8	24.4	20.4	27.0	26.0
Wagons												
Small	19.5	25.1	-	30.8	25.2	27.5	21.4	31.2	22.6	-	-	27.1
Midsize	-	-	-	-	-	-	-	21.5	-	19.6	-	19.9
All Sizes	19.5	25.1	-	30.8	25.2	27.5	21.4	31.1	22.6	19.6	-	27.0
SUVs (non-truck)												
Midsize	25.7	23.7	23.5	24.3	-	24.6	-	-	-	18.9	23.6	24.1
Large	23.4	-	22.4	-	-	20.7	-	-	-	-	-	22.9
All Sizes	23.7	23.7	23.0	24.3	-	23.4	-	-	-	18.9	23.6	23.6
All Cars												
Small	22.4	29.3	28.2	30.6	22.5	25.1	23.4	27.7	22.3	20.8	27.5	26.3
Midsize	25.2	27.9	25.3	23.9	24.3	26.7	24.4	21.0	25.6	20.0	24.2	26.0
Large	23.2	24.0	21.5	27.2	21.0	20.7	18.6	21.7	-	18.0	-	23.8
All Sizes	24.0	28.1	24.8	27.9	22.7	26.1	23.3	27.3	23.9	20.2	26.3	25.6
Vans												
Midsize	-	20.8	23.5	22.4	20.8	21.5	-	-	-	-	-	21.3
Large	15.8	-	13.7	-	-	-	-	-	-	-	-	15.4
All Sizes	15.8	20.8	21.9	22.4	20.8	21.5	-	-	-	-	-	21.0
SUVs												
Midsize	25.7	21.4	21.6	20.9	19.4	22.8	-	22.3	23.9	18.5	19.8	21.2
Large	18.2	15.2	18.9	21.9	18.6	17.7	20.3	21.4	-	16.6	19.6	18.4
All Sizes	18.3	20.9	19.6	20.9	19.1	19.8	20.3	21.7	23.9	16.9	19.6	19.8
Pickups												
Midsize	21.0	21.7	-	-	-	-	-	-	-	-	-	21.4
Large	17.3	17.3	17.4	17.6	16.1	16.4	-	-	-	-	-	17.1
All Sizes	17.3	17.5	17.4	17.6	16.1	16.4	-	-	-	-	-	17.2
All Trucks												
Midsize	22.0	21.2	22.0	21.2	19.8	22.6	-	22.3	23.9	18.5	19.8	21.3
Large	17.7	17.0	17.8	19.3	17.4	17.2	20.3	21.4	-	16.6	19.6	17.7
All Sizes	17.8	19.8	18.4	21.1	18.6	19.0	20.3	21.7	23.9	16.9	19.6	19.1
Fleet												
All Sizes	20.7	24.1	21.1	24.1	19.4	23.3	22.7	26.0	23.9	19.1	25.0	22.4

*Note: Two manufacturers, Hyundai and Kia, are not included in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data.

Table 33

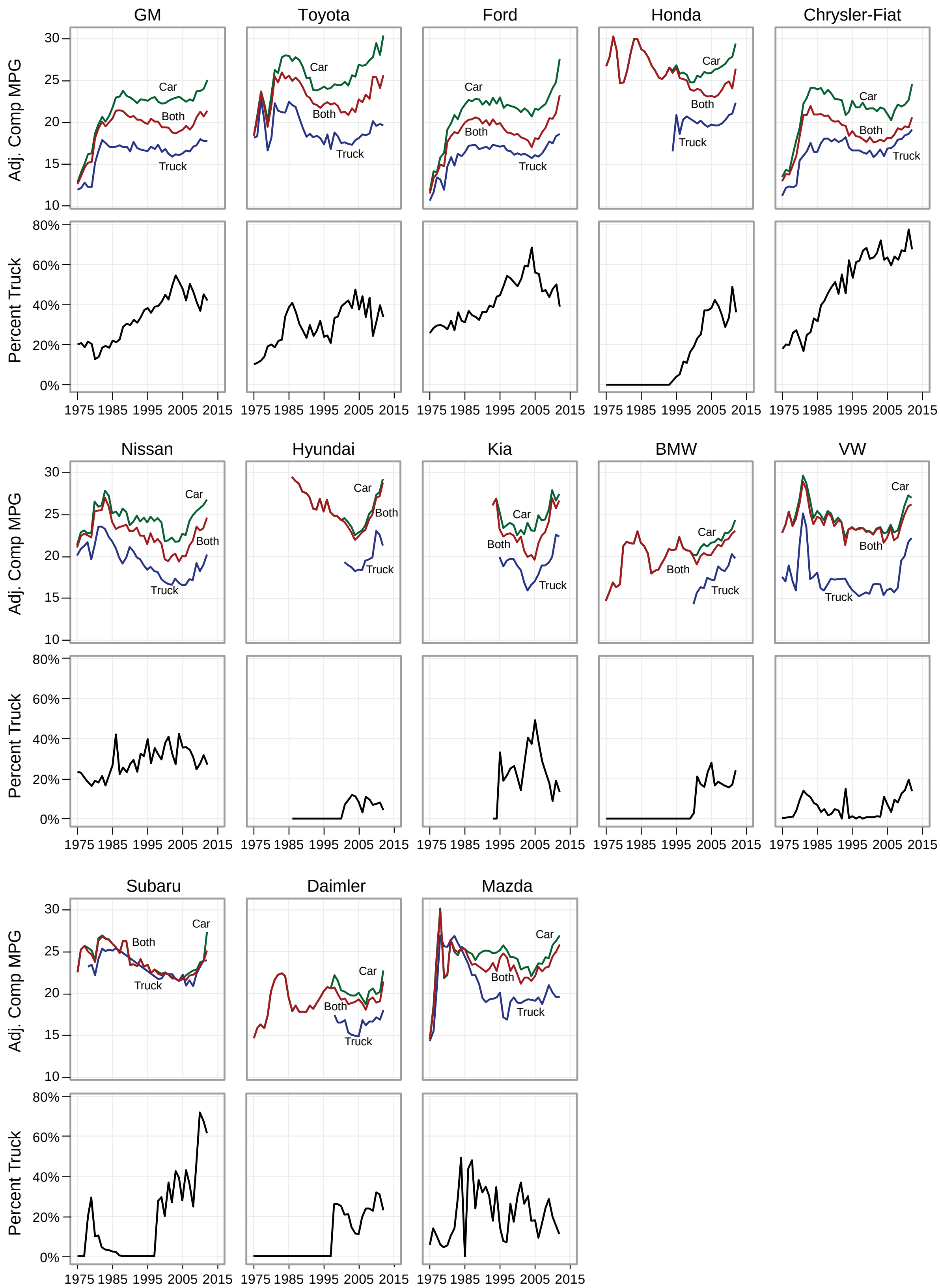
MY 2012 Adjusted Composite Fuel Economy by Vehicle Type and Size for Largest Manufacturers

Vehicle Type/Size	GM	Toyota	Ford	Honda	Chrysler-Fiat	Nissan	BMW	VW	Subaru	Daimler	Mazda	All
Cars												
Small	24.1	31.2	30.5	32.8	29.4	28.6	25.3	27.0	26.8	23.1	28.1	28.8
Midsize	26.7	31.5	26.3	23.3	23.9	26.4	25.1	26.4	25.2	23.8	26.3	27.5
Large	23.0	23.5	21.7	27.2	21.6	-	18.7	22.1	-	20.1	24.6	24.2
All Sizes	25.3	31.1	28.4	29.7	24.6	27.1	24.4	26.7	25.7	23.0	27.1	27.7
Wagons												
Small	21.8	25.1	-	30.2	25.2	27.6	21.4	31.5	29.6	-	-	27.5
Midsize	-	41.6	-	-	-	-	-	-	-	22.3	-	40.4
All Sizes	21.8	31.7	-	30.2	25.2	27.6	21.4	31.5	29.6	22.3	-	28.2
SUVs (non-truck)												
Midsize	22.9	23.6	23.5	26.5	-	24.9	-	-	-	19.1	23.0	24.3
Large	24.4	-	23.1	-	-	20.6	-	-	-	-	-	23.9
All Sizes	24.4	23.6	23.4	26.5	-	23.3	-	-	-	19.1	23.0	24.1
All Cars												
Small	24.0	30.8	30.5	32.3	29.2	28.3	25.3	27.4	28.8	23.1	28.1	28.7
Midsize	26.6	30.4	25.6	25.2	23.9	26.2	25.1	26.4	25.2	22.6	25.8	27.0
Large	24.0	23.5	22.4	27.2	21.6	20.6	18.7	22.1	-	20.1	24.6	24.1
All Sizes	25.1	30.4	27.6	29.4	24.6	26.8	24.4	27.0	27.4	22.7	27.0	27.3
Vans												
Midsize	-	21.1	23.9	22.4	20.9	21.5	-	-	-	-	-	21.4
Large	16.1	-	13.8	-	-	-	-	-	-	-	-	15.3
All Sizes	16.1	21.1	21.5	22.4	20.9	21.5	-	-	-	-	-	21.1
SUVs												
Midsize	19.2	21.4	21.7	22.4	20.3	23.8	-	24.1	24.0	18.4	19.2	21.9
Large	18.4	15.3	19.0	23.0	18.5	18.6	19.8	21.1	-	17.8	19.6	18.8
All Sizes	18.4	21.1	19.7	22.5	19.1	21.1	19.8	22.2	24.0	18.0	19.6	20.2
Pickups												
Midsize	21.3	20.8	-	-	-	-	-	-	-	-	-	21.1
Large	17.3	17.2	17.5	18.1	16.3	16.6	-	-	-	-	-	17.2
All Sizes	17.4	17.4	17.5	18.1	16.3	16.6	-	-	-	-	-	17.3
All Trucks												
Midsize	21.0	21.4	22.5	22.4	20.6	22.7	-	24.1	24.0	18.4	19.2	21.7
Large	17.7	17.1	18.0	21.8	17.9	17.7	19.8	21.1	-	17.8	19.6	18.0
All Sizes	17.8	19.6	18.6	22.3	19.1	20.2	19.8	22.2	24.0	18.0	19.6	19.4
Fleet												
All Sizes	21.4	25.6	23.2	26.4	20.6	24.6	23.1	26.2	25.2	21.4	25.9	23.8

*Note: Two manufacturers, Hyundai and Kia, are not included in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data.

Figure 29

Manufacturer Adjusted Fuel Economy and Percent Truck by Model Year



VIII. Alternative Fuel Vehicle Trends

This new section addresses original equipment manufacturer (OEM)[9] vehicles that are dedicated to, or are designed and expected to frequently operate on, alternative fuels. The main focus of this section will be data from MY 2012 vehicles that are designed and expected to operate on electricity and natural gas. OEM vehicles that operate predominantly on other alternative fuels, including ethanol, methanol, propane, hydrogen, etc., will be included in future reports if they become available to the public (the great majority of current ethanol flexible fuel vehicles are operated primarily on gasoline and therefore are not included in this section). Increasing interest in these alternative fuel vehicles is being driven by several factors: sustained high oil prices, concerns about future oil supplies and greenhouse gas emissions, and economic and national security issues associated with oil imports. This is an emerging area, with several new OEM alternative fuel vehicle models introduced in MY 2012 and many more planned for subsequent model years. Often, alternative fuel vehicle models are initially introduced in selected areas of the country, but the expectation is that many alternative fuel vehicle models will be available on a nationwide basis in the next few years.

The primary Trends database, on which the rest of this report is based, includes vehicle data from 1975 to the present only for vehicles that are dedicated to or are expected to operate primarily on petroleum fuels, i.e., gasoline and diesel fuel. The primary reason for this is simply that the number of vehicles that use alternative fuels sold by OEMs has been so low as to be inconsequential with respect to the overall database. In addition, some alternative fuels introduce complexities with respect to the core metrics that have traditionally been used in the analysis of the Trends database. For example, the metric of miles per gallon (mpg) can be simply applied to gasoline and diesel vehicles, but is a more complicated application for an electric vehicle whose fuel is not sold by the gallon. Also, given that some alternative fuels are produced in very different ways, relative to petroleum fuels, there are complex "life-cycle" emissions and energy accounting issues as well.

This distinction between the primary Trends database of petroleum fuel vehicles and this new section's focus on alternative fuel vehicles is challenged by those vehicles that can operate on both a petroleum-based fuel and an alternative fuel. There are currently a large number of these "flexible fuel vehicles" (FFVs) in the market that are capable of using either gasoline or E85 (a mixture of 85% ethanol and 15% gasoline, by volume), or any blend in between. However, these vehicles operate predominantly on gasoline (and ethanol-gasoline blends with low levels of ethanol) only.[10] EPA believes that there are many reasons why most consumers use gasoline in their FFVs: limited E85 fuel availability, greater vehicle range on gasoline, and E85 fuel pricing such that the fuel cost per mile is typically cheaper on gasoline. Accordingly, this report continues to assume that ethanol FFVs operate primarily on gasoline, with data from FFV operation on gasoline included in the primary database, and data from FFV operation on E85 excluded from the primary database. If, in the future, FFVs operate more often on E85 fuel, EPA will consider adding FFVs to this alternative fuel database.

Two other technologies that can use both a petroleum-based fuel and an alternative fuel are plug-in hybrid electric vehicles (PHEVs) and dual-fuel compressed natural gas (DF-CNG) vehicles.[11] While it is almost certain that PHEVs and DF-CNG vehicles will use at least some gasoline, there are two factors that strongly suggest that most owners of these vehicles will preferentially seek to use the alternative fuel as much as possible: 1) they have paid a substantial premium to buy a vehicle that can use the alternative fuel, and 2) the alternative fuel is

[9] This section, like the rest of the report, focuses only on OEM produced vehicles. There are aftermarket converters who modify OEM gasoline vehicles to operate on alternative fuels, but those vehicles are not accounted for in this section.
[10] Based on data from the Energy Information Administration, EPA projects that FFVs were fueled with E85 less than 1 percent of the time in 2008; see 75 Federal Register 14762 (March 26, 2010).
[11] While there are no MY 2012 OEM DF-CNG vehicles, some manufacturers are planning to introduce DF-CNG vehicles in the future.

considerably cheaper than gasoline, and provides an opportunity for the vehicle owner to recover the higher upfront cost of the vehicle through ongoing fuel savings. Because we expect PHEVs and DF-CNG vehicles to operate frequently on alternative fuels, they are included in this section and not in the primary Trends database.

With respect to other vehicles that may be introduced in the future that can operate on both petroleum and alternative fuels, EPA will determine on a case-by-case basis whether it is more appropriate to include them in the primary petroleum fuel database or in this separate alternative fuel vehicle section.

This report is the first in this series to include data on alternative fuel vehicles. The number of alternative fuel vehicle sales is still far too small (less than 0.2 percent of MY 2011 production) to have a large impact on the overall technology, CO_2 emissions, and fuel economy trends; however, there many additional alternative fuel vehicle models are expected to enter the market over the next few years.[12] At some point in the future, if the sales of alternative fuel vehicles continue to increase, EPA will consider merging this alternative fuel vehicle data with the primary Trends database.

Historical Trends

Gasoline and diesel vehicles have long dominated new light vehicle sales. OEM vehicles that operate frequently on alternative fuels have historically been available only in small numbers over the course of this report, though those limited production vehicles have in some cases created significant consumer and media interest.[13] From MY 1995 (which is as far back as reliable alternative fuel vehicle data was available for this report) to MY 2010, over 99.9% of all new OEM vehicles were petroleum fueled, with annual production of alternative fuel vehicles less than 4,000 per year. In MY 2011, several new alternative fueled vehicles were introduced into the market. The combined production of these vehicles led to an increase of alternative fueled vehicles from less than 1,200 in MY 2010 to well over 15,000 in MY 2011. While these vehicles still represent a very limited portion of overall new vehicle sales (approximately 12 million in MY 2011), this change is notable and is projected to continue.

In the mid-1990s, the state of California passed legislation creating the ZEV (Zero Emission Vehicle) mandate. In response to the ZEV mandate, OEMs began to produce limited numbers of electric vehicles. Most of these vehicles were leased, rather than sold, in small numbers in the state of California. The majority of these electric vehicles were small passenger cars, SUVs, or pickup trucks, including the GM EV1, the Toyota RAV4 EV, and the Ford Ranger EV. Dedicated CNG vehicles have been available in limited numbers for the last twenty years, most commonly during and after periods of rising gasoline prices. CNG vehicles have spanned a wider range of vehicles, from work trucks and vans to the Honda Civic Natural Gas, which has been available in select markets since MY 1998.

In MY 2000, five EVs, seven dedicated CNG vehicles, and one DF-CNG vehicle were available in the U.S. market. Chrysler-Fiat, Ford, GM, Honda, Nissan, and Toyota all produced at least one alternative fuel vehicle, with total production of about 3,500 vehicles. Most of these vehicles were produced in small volumes and only for a few model years. By MY 2006, only one alternative fuel vehicle was available, the Honda Civic Natural Gas. The Tesla Roadster, a dedicated electric vehicle, was introduced with limited production in MY 2008. From MY 2008 through MY 2010, the Civic Natural Gas and the Tesla Roadster were the only two alternative fuel vehicles produced by OEMs and available in some retail markets.

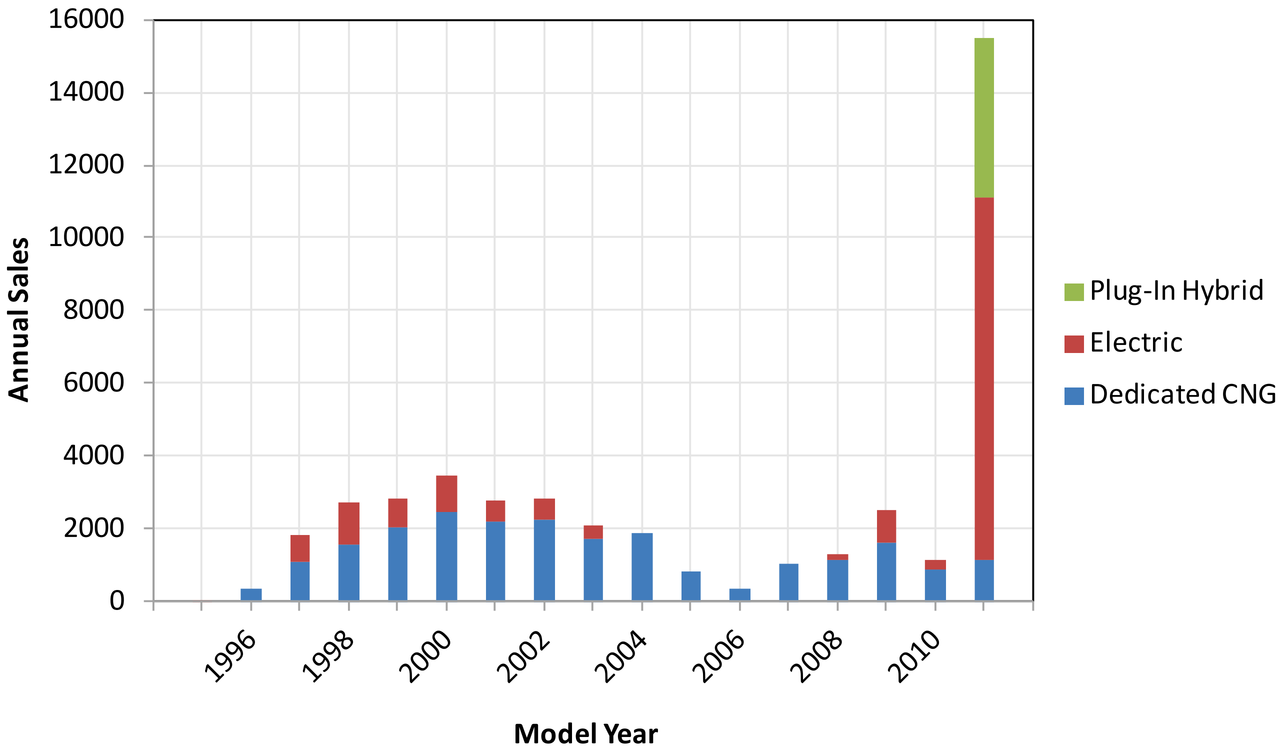
[12] For example, see list of potential future EVs and PHEVs at http://www.fueleconomy.gov/feg/evnews.shtml
[13] Millions of ethanol FFVs have been sold in recent years, but these vehicles have operated primarily on gasoline.

Two high profile OEM alternative fuel vehicles were introduced into the retail market in MY 2011, with much higher production volumes than previous alternative fuel vehicles: the Nissan Leaf electric vehicle (EV) and the Chevrolet Volt plug-in hybrid electric vehicle (PHEV). The Volt and Leaf had combined sales of nearly 13,000 vehicles in MY 2011, so sales of these two vehicles alone triple the total number of alternative fuel vehicles sold in any model year since 1995. The GM EV1, a notable alternative fueled vehicle, was leased from MY 1997 to 2000, with total production of 1,101 vehicles over four years [43]. The MY 2011 Nissan Leaf EV eclipsed the total EV1 sales mark in its first 6 months of availability, and it took only 4 months for sales of the MY 2011 Chevrolet Volt PHEV to do the same. Both the Leaf and Volt have had individual monthly sales higher than the total production of the EV1 over its four years of availability [44, 45]. The Tesla Roadster, a small all-electric sports car, was also available in MY 2011; however, sales were limited as Tesla ended production of the Roadster in preparation for production of the new Tesla Model S EV.

In addition to the Honda Civic Natural Gas, a second dedicated CNG vehicle was available from OEMs in MY 2011. The MV-1 is a specialty vehicle, available as a dedicated CNG vehicle that is a “Wheelchair Accessible Mobility Vehicle” [46]. While sales of dedicated CNG vehicles did not increase at the same rate as EVs and PHEVs in MY 2011, Honda announced in 2011 that it will be significantly expanding the availability of the Civic Natural Gas. When it was initially introduced, the Civic Natural Gas was only available to fleet customers, but it subsequently became available for retail in California, New York, Utah, and Oklahoma. Availability of the MY 2012 Civic Natural Gas was increased to 36 states, with more possible as Honda trains additional dealers [47].

Figure 30 shows the historical sales of EVs, PHEVs, and CNG vehicles over the last sixteen years (we do not have reliable data on OEM alternative fuel vehicles back to 1975). This figure was compiled from several data sources, including manufacturer CAFE reports, Ward’s, and publically available sales data. Figure 30 includes dedicated CNG vehicles, but not dual fuel CNG vehicles as sales data were not available for dual fuel vehicles. The data only includes offerings from manufacturers, and does not include data on vehicles converted to alternative fuels in the aftermarket.

Figure 30: Historical Sales of EVs, PHEVs and Dedicated CNG Vehicles



MY 2012 Vehicles

Since sales of alternative fuel vehicles have historically been limited, this section of the report will focus on currently available alternative fuel vehicles produced by OEMs and introduce several metrics that are new to this report and important for alternative fuel vehicles, instead of analyzing aggregated data about new vehicles sales. Table 34 shows the alternative fuel vehicles available from OEMs in MY 2012, as well as the classification of each vehicle, inertia weight class (IWT)[14], and footprint. These vehicles constitute a wide array of vehicle design, size, and function and range from a subcompact car to a large van.

[14] IWT is not precise weight of the vehicle, but curb weight plus 300 pounds, then rounded to nearest 250 or 500 pound weight class. See page 3 of body for more details.

Table 34: MY 2012 Alternative Fuel Vehicle Classification and Size [15]

Manufacturer	Model	Fuel or Powertrain	Car or Truck	Vehicle Classification	IWT (lbs.)	Footprint (sq ft)
BYD	e6	EV	Car	Non-Truck SUV	5500	47.4
Coda	Coda	EV	Car	Subcompact Car	4000	41.5
Ford	Focus	EV	Car	Subcompact Car	4000	43.5
Ford	Transit Connect	EV	Truck	Van	4000	47.9
Mitsubishi	i	EV	Car	Subcompact Car	2750	38.4
Nissan	Leaf	EV	Car	Midsize Car	3500	44.7
Tesla	Model S	EV	Car	Large Car	4500	53.5
Toyota	RAV4	EV	Car	Non-Truck SUV	4000	44.6
Chevrolet	Volt	PHEV	Car	Compact Car	4000	44.6
Fisker	Karma	PHEV	Car	Subcompact Car	5500	57.7
Toyota	Prius	PHEV	Car	Midsize Car	3500	44.2
Honda	Civic	CNG	Car	Compact Car	3000	43.5
VPG	MV-1	CNG	Truck	Special Purpose	5500	57.9

Table 35 shows basic technical specifications for the MY 2012 alternative fuel vehicles. The first eight vehicles are EVs and have different powertrain specifications. In an electric vehicle, the traditional engine and petroleum fuel system are replaced with an electric motor and a battery. The output of the electric motor can be classified in terms of horsepower and torque in the same terms as a more traditional petroleum fuel-based engine. The capacity of the battery is defined in terms of kilowatt-hours (kW-hrs). A battery with a larger capacity (in terms of kW-hrs) can store more energy on board the vehicle and is analogous to having a larger gasoline tank. It is important to note that the Motor HP and Battery kW-hrs values are component specifications, and may or may not reflect actual powertrain performance depending upon other vehicle components and design parameters (e.g., the motor may not fully utilize its maximum hp rating, and a battery may not be fully charged and/or discharged).

Table 35: MY 2012 Alternative Fuel Vehicle Powertrain Specifications and Range

Manufacturer	Model	Engine CID	Engine HP	Motor HP	Battery kW-hrs	Alternative Fuel Range miles	Total Range miles	Utility Factor
BYD	e6	N/A	N/A	101	31	122	122	N/A
Coda	Coda	N/A	N/A	134	32	88	88	N/A
Ford	Focus	N/A	N/A	143	26	76	76	N/A
Ford	Transit Connect	N/A	N/A	70	27	56	56	N/A
Mitsubishi	i	N/A	N/A	66	17	62	62	N/A
Nissan	Leaf	N/A	N/A	107	24	73	73	N/A
Tesla	Model S	N/A	N/A	349	83	265	265	N/A
Toyota	RAV4	N/A	N/A	154	50	103	103	N/A
Chevrolet	Volt	85	84	149	16	35	380	0.64
Fisker	Karma	122	290	402	20	33	240	0.62
Toyota	Prius	110	98	80	4.4	11*	540	0.29
Honda	Civic	110	110	N/A	N/A	N/A	N/A	N/A
VPG	MV-1	281	213	N/A	N/A	N/A	N/A	N/A

* PHEV operating partially in blended mode (includes some gasoline)

[15] There are several other non-petroleum fueled vehicles that have been in limited lease and/or demonstration programs, including the Honda Clarity FCX fuel cell vehicle, Mercedes F-Cell vehicle, etc. But, these vehicles have not been available to the general public at large.

PHEVs blend EV technology with more familiar powertrain technology from petroleum fueled vehicles. Current PHEVs feature both an electric drive system designed to be charged from an electricity source external to the vehicle (like an EV), and a gasoline internal combustion engine. There are generally three ways that a PHEV can operate:

1) Electric only mode – In electric only mode the vehicle operates like an EV, using *only* energy stored in the battery to propel the vehicle.
2) Blended mode – In blended mode the vehicle uses both energy stored in the battery *and* energy from the gasoline tank to propel the vehicle.
3) Charge sustaining mode – In charge sustaining mode, the PHEV has exhausted the external electricity from the grid that is stored in the battery and relies on the gasoline internal combustion engine. The vehicle will operate much like a traditional hybrid in charge sustaining mode.

The presence of both an electric drive system and an internal combustion engine results in a complex system that can be used in many different combinations, and manufacturers are each choosing to operate PHEV systems in different ways. This complicates direct comparisons among PHEV models in this report. For each MY 2012 PHEV, Table 35 shows data for the gasoline internal combustion engine in traditional terms of displacement and horsepower, and data associated with EVs, such as battery size and electric motor horsepower. Table 35 also shows the range on alternative fuel and total range. For the Chevrolet Volt and Fisker Karma PHEVs, which do not operate in blended mode, the alternative fuel range represent the range of those vehicles operating in electric only mode. However, for the Toyota Prius, the alternative fuel range represents the range of the vehicle operating in both electric only *and* blended mode, due to the design of the vehicle. The result is that the Prius uses some gasoline to achieve the alternative fuel range of 11 miles, while the Volt and Karma do not. Table 35 also introduces the concept of a utility factor. The utility factor is directly related to the alternative fuel range for PHEVs, and is a projection, on average, of the percentage of miles that will be driven using the alternative fuel (in electric only and blended modes) by an average driver.

The two vehicles that operate on CNG have traditional internal combustion engines. Many internal combustion engines designed to run on CNG are based on gasoline engines, with upgraded fuel systems and tanks designed specifically for natural gas. Therefore, specifications for CNG engines such as engine displacement and engine horsepower are essentially the same as those for traditional petroleum based engines.

This report has not previously tracked or analyzed data on the range of vehicles using petroleum fuels because gasoline and diesel vehicles can generally travel at least 300 miles without refueling, and gasoline and diesel fuel stations are common and well distributed across the United States (there are some rural areas where range may in fact be an important consideration). Most alternative fuel vehicles are expected to have lower vehicle range than gasoline and diesel vehicles, and all alternative fuel vehicles are likely to have more limited public refueling infrastructure. Range is of particular concern with electric vehicles, as today's battery technology limits the range of EVs to considerably less than that of comparable petroleum fueled vehicles. The availability of dedicated EV charging stations is also currently limited.[16] Table 35 includes range data for the alternative fuel vehicles when operating on the alternative fuel, as well as total electricity plus gasoline range for PHEV vehicles.

Table 36 shows four energy-related metrics for the MY 2012 alternative fuel vehicles (no entry is shown if the metric is not applicable to that vehicle technology). These data are generally included on the EPA/NHTSA fuel

[16] While dedicated EV charging stations are currently limited, electricity is available in nearly all but the most remote parts of the country. EVs can generally be recharged from a standard 110v outlet, though charging will be slower than at a dedicated 220v charging station.

economy and environment labels that are currently used for advanced technology vehicles (and are used on all vehicles beginning in MY 2013)[17]. These adjusted ("adj" in the table column headings) label values reflect EPA's best estimates of the energy consumption and fuel economy that these vehicles will achieve, on average, in real world operation based on EPA vehicle testing and our 5-cycle label methodology. Comparing the energy or fuel efficiency performance from alternative fuel vehicles raises complex issues of how to compare different fuels. For example, consumers and OEMs are familiar and comfortable with evaluating gasoline and diesel vehicle fuel economy in terms of miles per gallon, and it is the universal efficiency metric used throughout this report for the primary database. To enable this comparison for alternative fueled vehicles, the fuel efficiency of vehicles operating on CNG and electricity are evaluated in terms of miles per gallon of gasoline equivalent (an energy metric described in more detail below).

Table 36: MY 2012 Alternative Fuel Vehicle Fuel Economy Metrics

Manufacturer	Model	Adj Electric Consumption (kW-hrs/ 100 miles)	Adj Electric Fuel Economy mpge	Adj Gasoline Only Fuel Economy mpg	Adj Overall Fuel Economy mpge
BYD	e6	54	62	N/A	62
Coda	Coda	46	73	N/A	73
Ford	Focus	32	105	N/A	105
Ford	Transit Connect	54	62	N/A	62
Mitsubishi	i	30	112	N/A	112
Nissan	Leaf	34	99	N/A	99
Tesla	Model S	38	89	N/A	89
Toyota	RAV4	44	76	N/A	76
Chevrolet	Volt	36	94	37	60
Fisker	Karma	62	54	20	33
Toyota	Prius	29*	95**	50	58
Honda	Civic	N/A	N/A	N/A	31
VPG	MV-1	N/A	N/A	N/A	13

*Note: Electric consumption only. Overall, the Prius PHEV consumes *both* electricity and gasoline over the alternative fuel range of 11 miles, at a rate of 29 kW-hrs/100 miles and 0.2 gal/100 miles

** Prius PHEV mpge value reflects blended operation on both electricity and gasoline

The third column in Table 36 gives adjusted consumption rates for vehicles operating on electricity, which includes EVs and PHEVs. The units for electricity consumption are kilowatt-hours per 100 miles (kW-hrs/100 miles). The values for all of the EVs and PHEVs, with the exception of the Toyota Prius PHEV, reflect electric-only operation. The Toyota Prius PHEV adjusted electric consumption value represents the tested electric consumption of the vehicle during both electric only and blended modes. The Prius PHEV also consumes 0.2 gallons of gasoline per 100 miles during this combination of electric-only and blended modes.

The fourth column simply converts the adjusted electricity consumption data in the third column to adjusted miles per gallon of gasoline-equivalent (mpge), i.e., the miles the vehicle can travel on an amount of electricity that has the same amount of energy as a gallon of gasoline. For a vehicle operating on electricity, mpge is simply calculated as 33.705 kW-hrs/gallon divided by the vehicle electricity consumption in kW-hrs/mile. For example, for the Leaf, 33.705 kW-hrs/gallon divided by 0.34 kW-hrs/mile (which is equivalent to 34 kW-hrs/100 miles) is 99 mpge. Because the Prius PHEV consumes both electricity and gasoline over the alternative fuel range of 11 miles, the adjusted electric consumption value of 95 mpge includes both the electricity and gasoline consumption, at a rate of 29 kW-hrs/100 miles of electricity and 0.2 gal/100 miles of gasoline.

[17] These values represent a 55/45 city/highway weighting, consistent with the methodology used for labeling vehicles.

The fifth column gives adjusted fuel economy values for vehicles operating on gasoline only, which is relevant here only for the Chevrolet Volt, Fisker Karma, and Toyota Prius PHEV, while operating in charge sustaining mode. For PHEVs, the EPA/NHTSA label shows both electricity consumption in kW-hrs/100 miles and mpge, when the vehicle operates exclusively on electricity, and gasoline fuel economy in mpg, when the vehicle operates exclusively on gasoline.

The final column gives the adjusted overall mpge values reflecting the overall energy efficiency of the vehicle on all of the fuels on which vehicle can operate. While mpge does not reflect how all alternative fuels are sold (natural gas is in fact sold in gallons of gasoline equivalent, but electricity is not), it does provide a common metric with which to compare fuels that are sold in different units, and mpge is generally included on the EPA/NHTSA labels for that reason. For PHEVs, the mpge metric can also be used to determine the overall equivalent fuel economy for a vehicle that operates on two unique fuels. In addition to the energy metrics in the previous columns, the one key additional parameter necessary to calculate a combined electricity/gasoline mpge value for a PHEV is the utility factor that was introduced in Table 35. The Volt, for example, has a utility factor of 0.64, i.e., it is expected that the Volt will operate 64% of the time on electricity and 36% of the time on gasoline. Utility factor calculations are based on an SAE methodology that EPA has adopted for regulatory compliance.[18] For EVs and natural gas vehicles, the sixth column simply reports the mpge values that are on the EPA/NHTSA label. CNG vehicle mpge values are based on the energy equivalency assumption that a gallon of gasoline contains the same energy as 121.5 standard cubic feet of natural gas.

Tables 37 and 38 show several key CO_2 emissions metrics for MY 2012 alternative fuel vehicles.

Table 37 gives adjusted vehicle tailpipe CO_2 emissions values. EPA and vehicle manufacturers have been measuring tailpipe emissions since the early 1970s using standardized laboratory tests. Table 37 gives adjusted tailpipe CO_2 emissions which are the values that are included on the new EPA and NHTSA fuel economy and environment labels (and reflected in the label's Greenhouse Gas Rating) that are currently used for advanced technology vehicles. These adjusted label values reflect EPA's best estimate of the CO_2 tailpipe emissions that these vehicles will achieve, on average, in real world operation based on EPA vehicle testing and our 5-cycle label methodology. These values can be compared to the adjusted tailpipe CO_2 emissions values for gasoline and diesel vehicles in Section IV. EVs, of course, have no tailpipe emissions. For the PHEVs, the adjusted CO_2 emissions values here utilize the same utility factors discussed above to weight the CO_2 emissions on electric operation and the CO_2 emissions on gasoline operation. For natural gas vehicles, these values are based on vehicle test data and our 5-cycle methodology. It is important to note that, to be consistent with the primary Trends database, the tailpipe CO_2 emissions values given in Table 37 for CNG vehicles do not account for the higher global warming potency associated with methane emissions, which have the potential to be higher for some CNG vehicles.

[18] See http://www.SAE.org, specifically SAE J2841 "Utility Factor Definitions for Plug-In Hybrid Electric Vehicles Using Travel Survey Data," September 2010.

Table 37: MY 2012 Alternative Fuel Vehicle Adjusted Tailpipe CO_2 Emissions Metrics

Manufacturer	Model	Adj Tailpipe CO_2 (g/mile)
BYD	e6	0
Coda	Coda	0
Ford	Focus	0
Ford	Transit Connect	0
Mitsubishi	i	0
Nissan	Leaf	0
Tesla	Model S	0
Toyota	RAV4	0
Chevrolet	Volt	87
Fisker	Karma	169
Toyota	Prius	133
Honda	Civic	227
VPG	MV-1	541

Table 38 accounts for the "upstream" CO_2 emissions associated with the production and distribution of electricity used in EVs and PHEVs. Gasoline and diesel fuels also have CO_2 emissions associated with their production and distribution, but these upstream emissions are not reflected in the tailpipe CO_2 emissions values discussed elsewhere in this report. Combining vehicle tailpipe and fuel production/distribution sources, gasoline vehicles emit about 80 percent of total CO_2 emissions at the vehicle tailpipe with 20 percent associated with upstream fuel production and distribution. Diesel and CNG fuels have a similar approximate relationship between tailpipe and upstream CO_2 emissions (accordingly, CNG CO_2 compliance values are also tailpipe-only, and CNG upstream CO_2 emissions data is not included in Table 38).[19] On the other hand, vehicles using electricity emit no CO_2 (or other emissions) at the vehicle tailpipe; therefore all CO_2 emissions associated with powering the vehicle are due to fuel production and distribution. Depending on how the electricity is produced, these fuels can have very high fuel production/distribution CO_2 emissions (for example, if coal is used with no CO_2 emissions control) or very low CO_2 emissions (for example, if renewable processes with minimal fossil energy inputs are used).

Table 38: MY 2012 Alternative Fuel Vehicle Upstream CO_2 Emission Metrics

		Adj Tailpipe + Total Upstream CO_2			Adj Tailpipe + Net Upstream CO_2		
Manufacturer	Model	Low (g/mile)	Avg (g/mile)	High (g/mile)	Low (g/mile)	Avg (g/mile)	High (g/mile)
BYD	e6	218	352	527	132	266	441
Coda	Coda	186	299	449	109	222	372
Ford	Focus	129	208	312	49	128	232
Ford	Transit Connect	218	352	527	118	251	426
Mitsubishi	i	121	195	293	45	119	217
Nissan	Leaf	137	221	332	56	140	250
Tesla	Model S	154	247	371	59	153	276
Toyota	RAV4	178	286	429	96	205	348
Ford	Transit Connect	218	352	527	118	251	426
Chevrolet	Volt	202	259	334	128	185	260
Fisker	Karma	367	461	586	263	358	483
Toyota	Prius	200	221	248	143	164	192

[19] There is also considerable research ongoing on the topic on natural gas production, particularly with respect to the hydraulic fracturing ("fracking") processes.

An additional complicating factor in Table 38 is that electricity production in the United States varies significantly from region to region. Hydroelectric plants provide a large percentage of electricity in the northwest, coal-fired power plants produce the majority of electricity in the Midwest, and natural gas is increasing its electricity market share in many regions of the country. Nuclear power plants and renewable energy make up the balance of U.S. electricity production. In order to bracket the possible GHG emissions impact (there are additional complicating factors that are beyond the scope of this analysis and can only be addressed by sophisticated powerplant modeling), Table 38 provides ranges with the low end of the range corresponding to the California powerplant emissions factor, the middle of the range represented by the national average powerplant emissions factor, and the upper end of the range corresponding to the powerplant emissions factor for the Rockies.

Based on data from EPA's eGRID powerplant database, and accounting for additional greenhouse gas emissions impacts for feedstock processing upstream of the powerplant, EPA estimates that the electricity GHG emission factors for various regions of the country vary from 404 g CO_2/kW-hr in California to 976 g CO_2/kW-hr in the Rockies, with a national average of 651 g CO2/kW-hr [43]. Emission rates for the region encompassing New York City are approximately equal to those in California, and small regions in upstate New York and Alaska have lower electricity upstream CO_2 emission rates than California. However, California is a good surrogate for the "low" end of the range because California is a leading market for current EVs and PHEVs. Initial sales of electric vehicles have been largely, though not exclusively, focused in regions of the country with powerplant CO_2 emissions factors lower than the national average, such as California, New York, and other coastal areas. In addition, sales of hybrid vehicles have also been disproportionately higher in these same areas. [20] Accordingly, at least in the near term, EPA believes that the "average" vehicle operating on electricity in the near term will likely fall somewhere between the low end of this range and the national average.[21]

The third through fifth columns in Table 38 provide the range of adjusted tailpipe plus total upstream CO_2 emissions for EVs and PHEVs. For example, here are the steps that are used to calculate this value for the MY 2012 Nissan Leaf, which would be the same methodology for all EVs:

- Start with the label, or 5-cycle, vehicle electricity consumption in kW-hrs/mile, which for the Leaf is 34 kW-hrs/100 miles, or 0.34 kW-hrs/mile
- Determine the regional powerplant emission rate, regional losses during electricity distribution, and the additional regional emissions due to fuel production upstream of the powerplant (for California, these numbers are 299 g/kWh, 8.2%, and 24%). [48, 49]
- Determine the regional upstream emission factor (for California 299 g/kWh / (1-8.2%) * (1+24%) = 404 gCO_2/kWh)
- Multiply by the range of Low (California = 404 gCO_2/kW-hr), Average (National Average = 651 g CO_2/kW-hr), and High (Rockies = 976 g CO_2/kW-hr) electricity upstream GHG emission rates, which yields a range for the Leaf of 137-332 grams/mile.

The adjusted tailpipe plus total upstream CO_2 emissions values for PHEVs include the upstream CO_2 emissions associated with electricity operation and both the tailpipe and upstream CO_2 emissions associated with gasoline operation, using the utility factor discussed above to weight the values for electricity and gasoline operation.

[20] For an individual who wants to know the upstream greenhouse gas emissions associated with operating an EV or PHEV in his or her geographical area, use the emissions calculator at http://www.fueleconomy.gov/feg/Find.do?action=bt2

The values in columns three through five are tailpipe plus total upstream CO_2 emissions. But, all of the gasoline and diesel vehicle CO_2 emissions data in the rest of this report refers to tailpipe only emissions and do not reflect the upstream emissions associated with gasoline or diesel production and distribution. In order to equitably compare the overall impact of EVs and PHEVs with tailpipe emissions of petroleum fueled vehicles, EPA uses the metric “tailpipe plus net upstream emissions” for EVs and PHEVs. The net upstream emissions for EVs are equal to the total upstream emissions minus the upstream emissions that would be expected from a comparable-sized (using footprint as the size metric) gasoline vehicle. The net upstream emissions for PHEVs are equal to the net upstream emissions of the PHEV due to electricity consumption in electric or blended mode multiplied by the utility factor.

The upstream emissions for a comparable gasoline vehicle are determined by first using the footprint based compliance curves to determine the CO_2 compliance target for a vehicle with the same footprint. Since upstream emissions account for approximately 20% of total CO_2 emissions for gasoline vehicles, the upstream emissions for the comparable gasoline vehicle are equal to one fourth of the compliance target.

The final three columns of Table 38 give the adjusted tailpipe plus net upstream CO_2 values for the EVs and PHEVs using the same Low, Average, and High electricity upstream CO_2 emissions rates discussed above. These values bracket the possible real world net CO_2 emissions that would be associated with consumer use of these vehicles. For the Leaf, these values are simply the values in columns three through five minus the upstream GHG emissions of a comparably sized gasoline vehicle. Based on the MY 2012 CO_2-footprint curve, the adjusted 5-cycle tailpipe GHG emissions for a Leaf sized vehicle meeting its compliance target would be approximately 327 grams/mile, with upstream emissions of one-fourth of this value, or 82 g/mile. The net upstream emissions are determined by subtracting this value, 82 g/mile, from the total upstream emissions for the Leaf. The result is a range for the tailpipe plus net upstream value of 56-250 g/mile as shown in Table 38, with a more likely typical value in the 56-126 g/mile range.

For PHEVs, the adjusted tailpipe plus net upstream emissions values use the utility factor values discussed above to weight the individual values for electric operation and gasoline operation.

While there are still relatively few OEM alternative fuel vehicles in MY 2012, this represents a significant increase in both the number of models available and the total production of alternative fueled vehicles. Based on manufacturer announcements and projected sales, this segment of the market will continue to grow in MY 2013 and beyond. This report will continue to track the metrics presented in this section and report on trends in alternative fuel vehicle CO_2 emissions and fuel economy trends as more models are introduced and more data becomes available in future years.

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